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THE HUMAN ECHO

By Rufus T. Strohm

LEM BILLINGS is the kind of cuss that highbrows term ubiquitous; that is, he's all too plenty. He likes to gossip, loaf and smoke and lead the life Italian folk call *dolce far niente.* This firing boilers, to his mind, is nothing but a weary grind to which he's forced to buckle, whereas, as everybody knows, he'd sooner wear his Sunday clo'es and dally with pinochle.

He plugs along from day to day, but always takes the easy way of tending to his duties. He scorns the colleges and schools and vows that he's got better rules—and say, they sure are beauties! For instance, if he needs more air to make the furnace seethe and glare and keep the stack from smoking, he swings the fire doors ajar in manner quite spectacular, and thinks that he is stoking.

HE SPRAYS his fuel with a hose until the mixture slips and flows like mud flats in a shower. He piles a half a ton of coal inside the yawning fire-hole and then he loafs an hour. He opens up the blowoff cock in one-tenth second by the clock nor lets an eyelash flicker, and when at length he yanks it shut, this perfect specimen of nut performs that action quicker.

So far as judgment goes, his head might just as well be made of lead, or stuffed with pulp or shavings; for when his friends try to be nice, he treats their kindly meant advice as nothing more than ravings. By modern firemen he's classed as but an echo of the past; he apes his predecessors, who modeled all their ways by guess, and so Lem's practice is a mess, for they were rotten guessers.

Remodeling Old Power Stations—Boiler-Plant Improvements

By L. R. LEE*

A STEAM-ELECTRIC generating station is naturally divided into two parts, the boiler plant and the generating plant, commonly referred to as the boiler room and engine or turbine room. There are, as a rule, more opportunities for increasing the capacity and economy in the boiler room than in the turbine room. The cause of this is not hard to understand when it is considered that the modern boiler is fundamentally but little different from the one sold ten, fifteen or even twenty years ago. The modern boiler meets new requirements of pressure, size of furnace, superheat, etc. However, with proper regard for the pressure limit the old boiler can usually be brought up to date so that it will give a satisfactory account of itself when compared with the modern boiler. There are one or two tests that should be applied to all old boiler plants to determine whether or not they are worth extensive remodeling or whether they should only be kept in good repair until such time as conditions allow of the entire replacement with new equipment. These tests are about as follows: Will the present boilers admit of furnace improvement that will secure 200 per cent continuous rating? With the boilers operating at 200 per cent rating, will the exit-gas temperatures be more than 550 deg., and if so, will the space limitations allow installation of suitable economizers? May the boilers be insured for 175 lb. working pressure over a reasonable number of years to come?

To meet demands for increased capacities and better economy, companies are interested at this time in enlarging and bringing up to date their old power plants. Moreover, the high cost of fuel has discouraged many isolated plant owners from further use or extension of existing facilities, hence the users of electric power are multiplying and its use in residences has become an appreciable factor in increasing central-station day-power load. Therefore it behooves the central-station executive to put his plant in order, that he may realize a maximum on the investment that he already has.

If these three questions can be satisfactorily answered, then undoubtedly the plant is worth reclaiming and then the extent of improvements may be balanced against their cost to determine the amount of improvements to be made.

In the same way, after the tests have been applied to see whether the plant is worth reclaiming, it is well to catalog the limitations of the plant and to rate these limitations so that the money spent will be first invested where it will bring in the largest return. Some of the most important of these questions are usually found to be as follows: Coal and ash handling, furnace capacity, draft conditions, capacity and general condition of auxiliaries.

Checking Station Results

It is also important in laying out the improvements for the old plant to see how much can be done toward installing such equipment as will increase the possibility of checking the results from the station. The two principal things to be found out in the boiler plant are the amount of coal burned and the quantity of steam generated. With these two facts actually determined, a pretty close check can be kept upon the operation. Much detailed data must, of course, be kept in checking economies and proper operation, these data being secured in a modern plant by means of such instruments as water meters, recording thermometers, recording pressure gages, draft apparatus, furnace meters, and so on. The most of such equipment being relatively inexpensive compared to the investment in the plant, it requires only careful selection and a sense of proportion not to have too many instruments to so overburden the operating man with details that he may neglect the main operation. The old plant usually lacks facilities for handling coal and ashes. Where there are any such facilities, they are usually limited in capacity and require excessive maintenance and labor for operation. The very fact that coal has increased so much in cost makes it necessary to burn the lower grades as far as possible; therefore the central station must expect to handle relatively more coal and ash than formerly, and to keep within reasonable cost, they must be handled with little labor. A plant of any considerable capacity must receive its coal by railroad car, steamship or barge and should be provided with facilities for unloading quickly with little manual labor, and it should also have facilities for receiving all grades of coal; that is, it should be provided with crusher equipment so that run-of-mine, lump or screenings may be received with no inconvenience. Storage should be provided so that at least a thirty-day supply may be carried as a so-called emergency or seasonal storage, while a smaller storage of about two days' supply may be in continuous use. It is also desirable to arrange to dispose of the ashes directly into railroad cars with little or no manual labor.

Stoker Capacity of Boiler Plant

Increasing the capacity of the boiler plant really means only increasing the facilities for burning coal. Practically any water-tube boiler, if properly set and kept clean, will permit of driving to higher capacities, depending upon the furnace arrangement which may be worked out to advantage. Therefore, the furnace conditions must be first studied to see how much coal can be burned in each and every furnace. If stokers are already provided and capacities of 200 per cent or more are not easily obtained, then the stokers have insufficient capacity or insufficient draft. Stoker capac-

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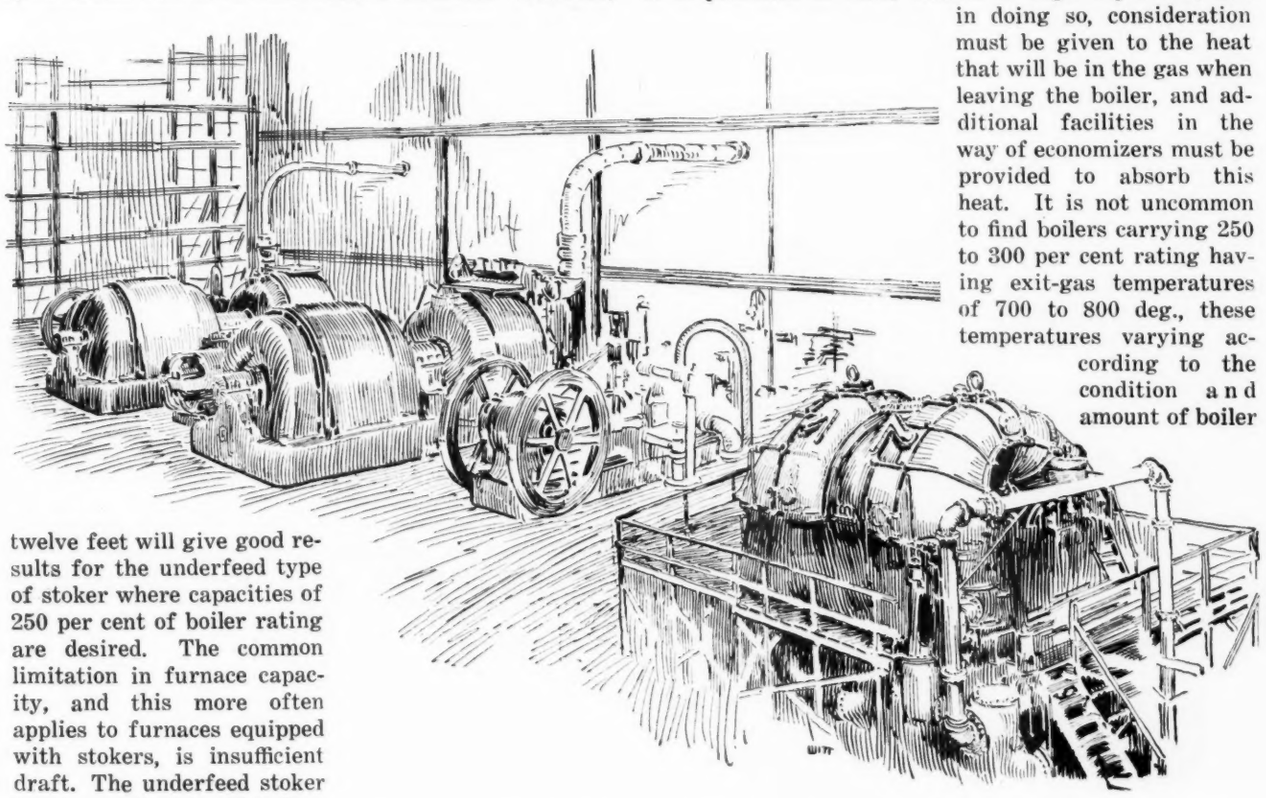
ity may be limited by the actual size of the stoker itself or by the volume of furnace provided over the stoker. In other words, stokers are often put under old boilers that are not set high enough. There are two ways of increasing the height of the furnace: First, to raise the boiler, and second, to drop the stoker below the boiler-room floor level. It is often difficult to raise old boilers, owing to building conditions, but it frequently happens that it is comparatively easy to drop the furnace level so that part of the basement may be used for the stoker installation. The height of boilers of the B. & W. type is usually spoken of as the distance between the front end of the lower row of tubes and the floor line. All boilers having less than ten feet between the floor line and the lower row of tubes at this point are considered boilers of low setting, and this dimension may be profitably made up to fifteen feet or in some cases even more. However,



twelve feet will give good results for the underfeed type of stoker where capacities of 250 per cent of boiler rating are desired. The common limitation in furnace capacity, and this more often applies to furnaces equipped with stokers, is insufficient draft. The underfeed stoker is often applied to old boilers with the idea of increasing economy and capacity with providing for additional draft at the boiler uptake. The underfeed stoker or forced-draft type burning larger quantities of fuel, therefore increasing the volume of gas to be handled, calls for a high draft at the boiler uptake. Natural draft provided by stacks may, of course, always be used to advantage, but the most satisfactory way to increase the draft at the boiler uptake is by induced-draft fans. These may be arranged to discharge into the base of existing stacks, they may be motor-driven and may be obtained in the high-speed radial-flow types which allow installation in very limited quarters.

Another factor, and one that is often overlooked in the draft question, is the dimensions of the boiler uptake, the size of the flues and connections with the stack. It is extremely important that the opening out of the boiler be made the maximum size permitted by the construction of the unit and that the flue be as large and as straight and free from sharp turns as possible. It is equally important to see that the flue is tight. Brick flues can be made satisfactory, but old brick flues are often full of leaks that are not very apparent unless a thorough inspection is made. Therefore, it is important in studying the condition of any given boiler to see: First, if the furnace volume is ample; second, if sufficient draft is provided both at the boiler uptake and under the fuel bed. These factors have most to do with the capacity of the furnace, although of course they will have considerable effect on the economy. However, the economies of the boiler plant must be looked to: First, in regard to the tightness of the boiler setting; second, the cleaning of the boiler to see that it is free from soot on the outside of the tubes or scale on the inside; and third, to consider the exit temperatures of the gas leaving the boiler. It is practical to force boilers to high capacities, but in doing so, consideration must be given to the heat that will be in the gas when leaving the boiler, and additional facilities in the way of economizers must be provided to absorb this heat. It is not uncommon to find boilers carrying 250 to 300 per cent rating having exit-gas temperatures of 700 to 800 deg., these temperatures varying according to the condition and amount of boiler surface provided. It is usually profitable to install sufficient economizer surface to reduce the flue gas to temperatures of 400 deg. and less. As a general rule the space available, in old plants, for economizer surface will determine the amount of surface rather than the temperature of the gas. By working over the old layout so that the boilers, which are quite commonly installed in batteries, may be treated as units, economizers can usually be installed of ample size to provide for quite high overload capacities. These unit arrangements may be worked out so that a battery of boilers, single economizer and induced-draft fan and forced-draft fan may become a unit discharging its flue gas into a common flue which may lead to existing stack. In some cases short stacks may be provided for each induced-draft fan to good advantage.

The steam-pressure limitation which will always be involved in old boiler plants is usually not a very serious one, and by installing superheaters the tem-

perature of the steam can be raised to such a point that the economy of the station will compare favorably with modern plants. Superheat will usually require looking into the main steam-pipe layout. If the main steam layout has in its make-up numerous cast-iron flanges, fittings, valves, etc., it may be necessary to provide new main steam lines. If this is required, it is important to look over the layout and see that the new lines provided are not too large. Practically all old steam piping was put in of such large size that the steam velocity was very low and would be unsuited to handling steam even if its construction was adequate. By installing the new piping with a few right-angle turns all made up of pipe bends, it is practical to use steam velocities up to 8,000 ft. per sec. This decreasing the size of the steam-pipe lines makes it possible to make considerable saving, not only in the pipe itself, but in the cost of the valves. The smaller valve is also a more satisfactory piece of equipment, as it is usually tighter and the cost of repairing is proportionately reduced.

Increased Boiler-Feed Supply

Increasing the capacity of boilers will call for enlarged feed-water supply, and if the present facilities consist of reciprocating feed pumps, which take up much valuable space, it is well to consider the modern centrifugal pump, either motor- or turbine-driven, and in making a new layout to ascertain if the number of feed-pump units cannot be decreased to advantage. Two or three good feed-pump units should be sufficient for a fair-sized plant. The smaller number of units will allow a considerable saving to be made in piping and savings in repairs and other operation.

As practically all old plants are provided with some form of feed-water heating equipment, it is well to ascertain if all the steam from auxiliaries is used up in the feed-water heater to advantage and if the existing heater provides a reasonable increase in the temperature of the feed water and still does not use up all auxiliary steam. Investigation should be made to see if the amount of auxiliary steam cannot be decreased by the application of motors to auxiliaries rather than to increase the size of the feed-water-heater equipment.

If it is found practical to install economizers, feed-water temperatures of 150 deg. or more are entirely satisfactory and sufficient, and the power for driving auxiliaries can usually be efficiently made by the main turbine units; and there certainly is great satisfaction in the operation of the motor-driven auxiliary, considering the elimination of small piping and the cost of its repairs and maintenance.

The motor-driven forced-draft and induced-draft fans are extremely satisfactory as well as motor-driven centrifugal feed-water pumps. Stoker drive may also be motor-driven and variable-speed alternating-current motors can be obtained that are satisfactory for such work. There are, in fact, very few arguments for the steam-driven auxiliary, while there are a great many arguments against its use. It is no longer necessary to use steam-driven auxiliaries in order to obtain variable or regulated speeds or to obtain reliability; there is nothing more reliable in the power station than the electric motor, and there is probably nothing that is more easily kept in good condition.

All efficient designers of modern steam plants aim to lay out the plant as simply as possible with a minimum amount of steam piping, both large and small. The old station always represents an accumulation of piping and it is well to investigate carefully to see if considerable piping can not be eliminated to advantage. All piping is subject to heat loss, either by direct leakage or by heat radiation due to insufficient covering. Pipe covering is expensive and hard to maintain, especially on small pipes around the boiler room. Superheated-steam lines need no drains or trap systems. A few well-located drain valves to free cold pipe from water are sufficient.

Preventing Leaks in Brickwork

Boiler settings must be continued to be made up largely of brickwork and there is always great opportunity for small leaks in the brickwork itself and in the connections between the brickwork, boiler, flue, and door-frame connectons. In recent years there have been manufactured many boiler brickwork coatings that will prevent leaks through poor joints and cracks. The chief essential of such coatings is that it shall remain in a more or less plastic state and not dry hard, so that as the brickwork cracks the coating will retain its continuity over the cracks and prevent air being drawn in. Asbestos may be used to advantage in stopping leaks around door frames, flue connections and all boiler connections. Such work must be carried on continually or at regular intervals as new leaks will reoccur from time to time.

Within the boiler itself there are some improvements that may be applied to old work at a relatively small cost. Practically all boilers are provided with baffles of one shape or another. Heretofore these baffles have been made of brick or tile of various dimensions, very often of special shapes and small in size. The natural consequence of using numerous small sections of brick or tile is that the baffles have a great many joints, all of which must admit of some leakage even when new. As time goes on and new tubes are put into the boiler and the tubes themselves become somewhat warped so that the baffles are deformed, the leakage increases. Several companies have perfected baffle designs of considerable merit. The fundamental feature of all these different designs is monolithic construction. Some companies use a quantity of plastic material, building up the entire baffle by means of form work and pouring in the plastic material. Others use a combination of tile and plastic, obtaining the same results. As a general thing there is considerable merit in these designs and they go a long way toward securing tight baffles.

Burning Low-Grade Fuel

Burning the lower grades of coal at increased rate probably causes more soot and ash to be deposited among the tubes and baffles of boilers than formerly. The old method of blowing out this soot by means of a hand lance from the side of the boiler is rather inadequate and unsatisfactory, therefore the soot blower has become an indispensable piece of boiler equipment. Practically no new boiler layouts are now made which do not provide mechanical soot blowers, which in most cases will thoroughly clean soot or ash, which may be deposited in the boiler in a very short space of time. The advantage in the use of this equipment is that not only is the boiler cleaned more thoroughly than by the hand method, but since it is done more easily it is done more regularly by the operating force and with a consequent saving in labor cost and with increased advantage in the operation of the boiler.

There has been a tendency, I believe, in a great many cases in installing soot blowers, to provide rather more than the situation warrants. It has been my experience that a soot blower will clean more surface than the manufacturers claim, or in other words, fewer elements are actually required than advocated by the manufacturer. The essentials of installing soot blowers are to see that they are properly located and that full boiler pressure, preferably of superheated steam, is provided at each soot-blower element so that a high velocity may be set up when the blowers are placed in action and that the steam may be thoroughly dry; otherwise the wet steam coming in contact with the hot soot-blower elements may cause them to be warped out of shape. It is, of course, important, in installing the soot-blower elements in the front passes of the boiler, to be sure that they are protected from the direct furnace heat as much as possible.

In remodeling an old plant, a great deal depends on the designer's sense of proportion. It should be obvious that the old plant cannot reach the same standard as a new one. When thought is not given to this phase of the situation, too much may be spent on one detail, leaving too little to spend upon another. Improvements may be made in steps, but some improvements amount to very little unless others are also made. For example, a very fine stoker layout would be useless if proper draft equipment was not also provided. In the same way stokers without any coal- and ash-handling facilities would in most cases be rather expensive to operate.

I believe that certain modern boilers may be and should be operated at ratings of 300 per cent and over. However, there are very few old boiler plants from which it would be profitable to try to get 300 per cent boiler ratings.

Much may be accomplished around most old boiler plants by improving working conditions. For example, a good boiler room does not have to be hot and gloomy, or positively dark; windows should be added wherever possible to admit daylight and fresh air; ventilators should be installed to remove heated air and gases. These improvements will assist in improving labor conditions and also insure more attention being given to detailed repairs, such as the care of recording instruments, small auxiliaries and work of like nature. Men will do more and better work where conditions are good than where they are bad and disagreeable.

Falls of Ohio Can Be Harnessed

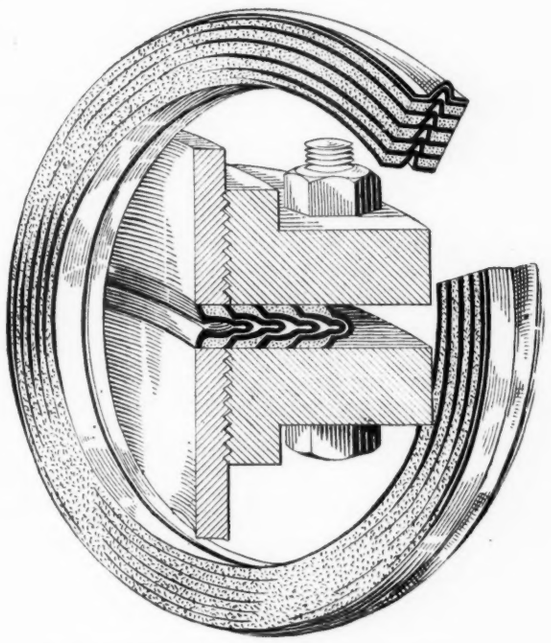
Production of electric power from the falls of the Ohio River at Louisville, Ky., is a practical project, according to a committee composed of W. H. McAlpine, principal assistant, United States Engineers, L. S. Streng, engineer Louisville Gas and Electric Co., and F. H. Miller, Louisville Railway Co., in a report read by the former at the Engineers and Architects' Club on Nov. 20.

Although the enterprise is not without its difficulties, nevertheless it warrants further investigation and study. The report estimated that a plant based on a 50,000-hp. basis and working on a 50 per cent "load" could be used from 65 to 75 per cent of the time. It was also estimated that the plant would be idle about sixty days a year because of low water. An auxiliary steam plant would be necessary in conjunction with a hydro-electric station. If the dam were elevated to flood stage it would still be impossible to have a hydro-electric plant in continuous operation during the entire year; it was estimated that in this case the plant would be idle at least forty-five days a year.

The cost of building a wall, power-house site and generating equipment was placed at $11,000,000 at present construction prices, and the cost of erecting the steam plant was estimated at $8,000,000. Members of the club termed as "criminal waste" inaction in not harnessing the falls, and a resolution prepared by a special committee was adopted unanimously, asking Congressman Charles F. Ogden to obtain, if possible, such legislation as will result in authorizing the United States to make such an investigation as may be necessary to determine the feasibility of water-power development. It is generally expected that favorable action will be taken early in the new year.

Flexitallic Boiler and Flange Gaskets

Flexitallic gaskets consist of a cushion of waterproof asbestos spirally wound to conform with metal strips, put in place under pressure; the metal strips are wound



GASKET BEFORE AND AFTER APPLYING TO FLANGE JOINT

in a spiral dovetail shape, starting on the inside and working out ply by ply to the size of the gasket required, about 19 plies to every inch width of flange. This makes it practically impossible to blow out, and at the same time creates great resiliency.

The illustration shows the design of a gasket before and after it had been compressed between pipe flanges. As the metal is on edge and at right angles to the line of pressure, the gasket does not adhere to fittings and takes care of expansion, contraction and vibration.

This gasket is made by the Flexitallic Gasket Co., Camden, N. J. It is suitable for use on boiler manholes and tube caps for water-tube boilers; also pipe flanges, superheaters or on any joint where it is difficult to make the gasket hold tight.

The Solid-Injection Oil Engine

By EDGAR J. KATES

THE article on "The Pressure-Injection and the Air-Injection Oil Engines," by Hermann Shultz, in the Dec. 14 issue of *Power* attempts to show why pressure-injection oil engines (or solid-injection engines as termed in this country) can never be successful because they are based upon a wrong principle; whereas, in point of fact there are on the market solid-injection engines that are actually doing the very things that he claimed to be hopeless of accomplishment.

By solid-injection engines is meant oil engines in which the charge of fuel is sprayed into the combustion chamber solely by pressure from a pump and without the aid of air injection.

In the previous article it is stated: "In truth one is compelled to speculate more or less if the designers of these latter types of motors really understood the process of combustion occurring in the cylinder of the gas motor, or rather, the oil engine. Surely, if the processes of vaporization or gasification, ignition and combustion were fully appreciated, hope that the pressure injection, or as the Americans term it, solid injection, would show an economy anywhere near the Diesel motor would vanish." In view of the fact that one of the successful solid-injection engines built in America is constructed by a factory that has built Diesel engines for a number of years, the development of these later designs can hardly be attributed to lack of appreciation of the Diesel principles.

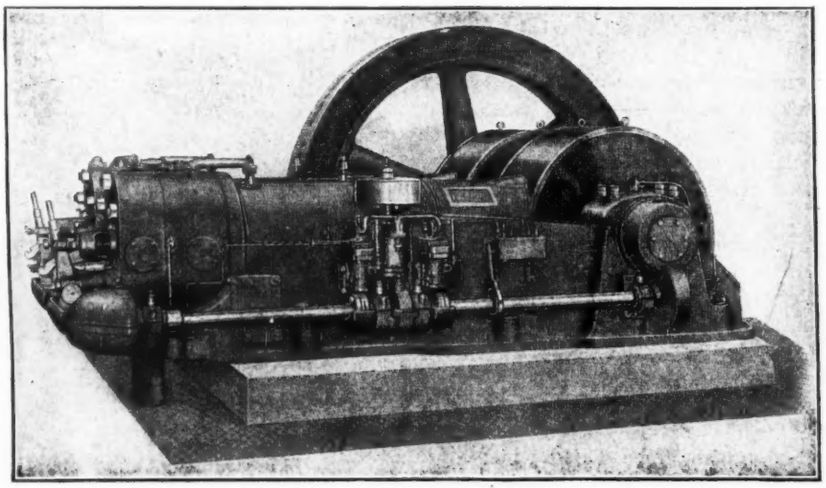


FIG. 1. 200-HP. TWIN CYLINDER DE LA VERGNE SOLID-INJECTION OIL ENGINE

The principal objection advanced in the article to the solid-injection oil engine was that it was impossible to obtain complete combustion of the fuel and consequently the engine must necessarily be inefficient. That this is not the case is demonstrated by actual tests of solid-injection engines in sizes of 100 and 150 hp. per cylinder which have shown a fuel consumption of only 0.41 lb. of oil per brake-horsepower-hour, which is equal to or better than the fuel consumption of Diesel engines of corresponding size. The regular manufacturers' guarantee on these engines is 0.45 lb. of oil per brake-horsepower-hour, which is as good as the guarantee offered by Diesel manufacturers. A detailed test report on one of these engines is given in Table I.

In the Diesel engine the atomization of the charge of oil inside the combustion chamber is accomplished by means of a blast of compressed air at a pressure of about 1,000 lb. per sq.in., the oil being all delivered to the spray valve by the fuel pump before the spray valve is opened by the cam. In the solid-injection engine the atomization results from the oil being delivered at high velocity and with a rotary motion through an orifice, which causes it to break up into an extremely fine mist in the combustion chamber. The spray valve is not mechanically operated, but opens only when the oil pressure is against it. The fineness of the atomization in the solid-injection engine is fully as good as in the air-injection Diesel engine, the completeness of the combustion being evidenced by low fuel consumption and complete lack of smoke in the exhaust gases.

A typical solid-injection engine as now manufactured in this country is illustrated in Figs. 1 and 2. This is a single-acting, four-stroke cycle engine, the sequence of events being as follows:

Suction Stroke—The intake valve is opened mechanically, and the piston is moved forward on the suction stroke, drawing in a full charge of pure air.

Compression Stroke—The intake valve is closed. The piston returns, compressing the air from the cylinder into the combustion chamber to a pressure of approximately 330 lb. per sq.in. On account of the excellent spraying action of the fuel, which fills the entire combustion space with a uniformly distributed oil mist, this compression pressure is ample to cause ignition.

Working Stroke—The oil is injected slightly in advance of inner dead center. Combustion at constant volume occurs, and the pressure rises from the compression pressure to approximately 500 to 550 lb. per sq.in. The piston starts out on the working stroke.

Exhaust Stroke—Near the end of the working stroke the exhaust valve is mechanically operated. The pressure drops and the piston returns, expelling the burnt charge.

It should be noted that this engine is entirely free of hot caps, uncooled castings, hot surfaces or igniting plugs, ignition being brought about solely by the air temperature resulting from the compression of the cylinder charge. The temperature required to effect ignition in the solid-injection engine is less than is usual in the Diesel engine, for two reasons: First, because the entire combustion space of the solid-injection engine is filled with a uniformly distributed oil spray, whereas in the Diesel engine the mixture is not homogeneous; and secondly, because in the solid-injection engine the incoming spray of oil is not chilled through expansion of the injection air as is the Diesel.

In this connection the writer takes exception to the statement in the preceding article reading: "The air blast performs a greater service in the combustion chamber than in the spray valve. The amount of fuel injected into the cylinder has no effect on the process of combustion, since the air blast effectually breaks up and mixes the low-load charge as well as it does the full-load charge."

As a matter of fact, in most Diesel engines the chilling effect of the injection air upon the fuel is so great that at light loads it is necessary to reduce the pressure of the injection air in order to prevent occasional failures of the fuel to ignite, or in other words, misfiring. This of course cannot take place in the solid-injection engine as the oil is injected entirely by mechanical pressure and there is no highly compressed air blast to chill it.

Contrary to the opinions expressed in the previous article, the fuel-pump pressure in the solid-injection engine is by no means excessive. The pressure in the fuel line of the successful solid-injection engine already described has been measured and was found to be between 1,500 to 2,000 lb. per sq.in. at the moment of maximum pressure. When it is considered that this is a liquid pressure and that hydraulic installations commonly use pressures between 5,000 and 10,000 lb. per sq.in., the pump pressure in the solid-injection engine is seen to be well within the limits of good engineering practice. It is far easier to maintain a liquid pressure of 2,000 lb. per sq.in. than an air pressure of 1,000 lb. per sq.in. as used in the Diesel engine. The fuel pump of the solid-injection engine is as simple and as sturdy as that of any good Diesel engine.

In the earlier article it is stated that "a more important feature of the action of this type of injection (referring to solid injection) is the high maximum pressures occurring at the moment of fuel admission. Frequently, the indicator cards show pressures several atmospheres higher than is usual in Diesel engines." It is also stated that "the excellent efficiencies shown by some of these engines are undoubtedly secured with a maximum explosive pressure well above 800 lb." That this is not the case with a well-developed solid-injection engine is shown by the typical indicator card, Fig. 3, which was taken from the same type of engine for which Table I gives a test report. It will be noted that the maximum combustion pressure is 520 lb. per sq.in., which is well within Diesel-engine limits, and in fact less than is used on many Diesel engines.

It is claimed by the author of the preceding article that solid-injection engines smoke badly at full load and that during the war this was the chief criticism against this design. The author goes on to explain that this is due to the character of the spray action, there being no expansive force to cause diffusion. The result of this is said to be that only the outer portions of

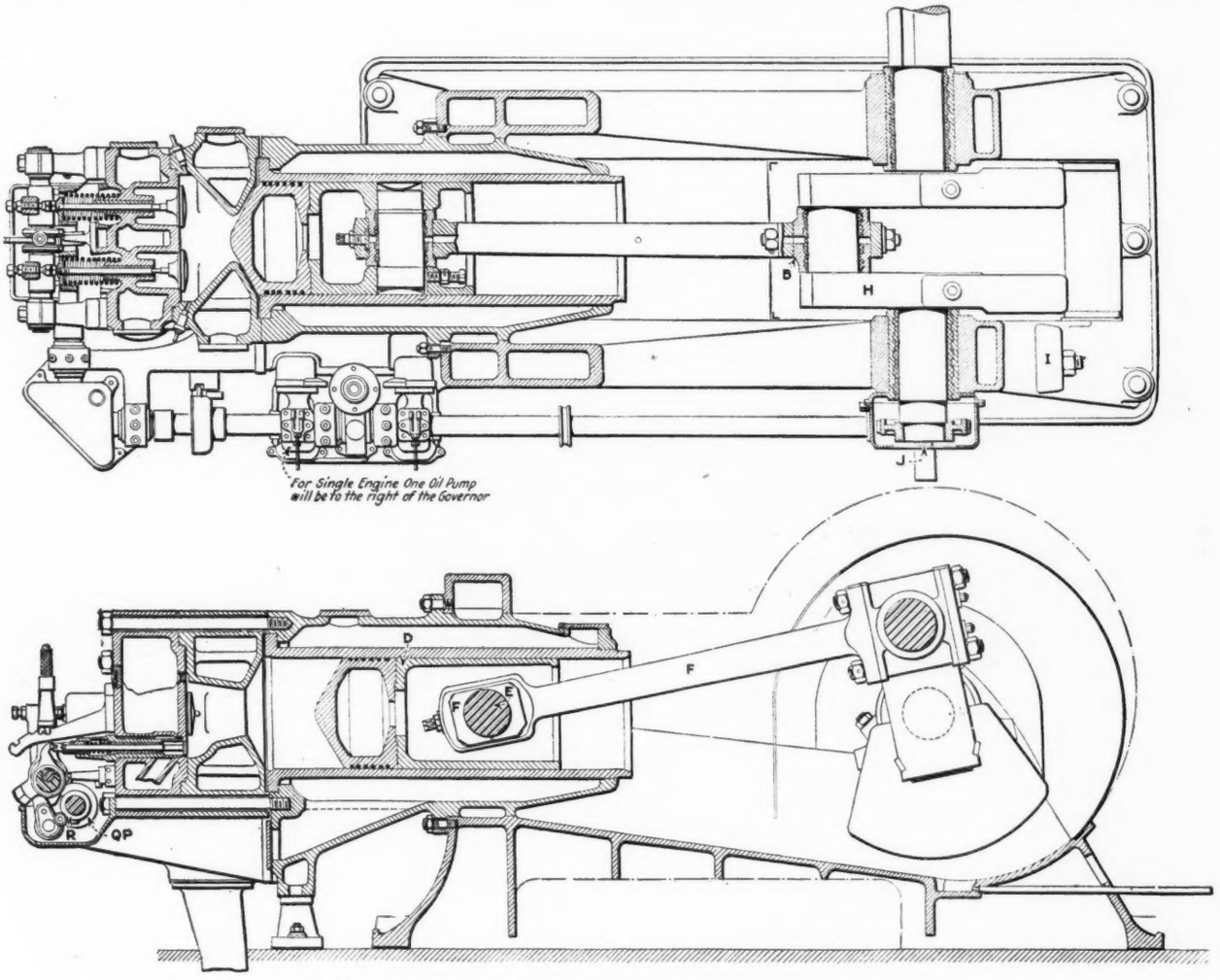


FIG. 2. SECTIONAL VIEW OF SOLID-INJECTION OIL ENGINE

the spray are broken up while the interior is fairly solid, resulting in this portion of the oil going through a "cracking process" and depositing heavy hydrocarbons which appear as smoke.

With due respect to the theory, the fact is that a properly designed solid-injection engine does not smoke at all at full load or even at a moderate overload. The form of the spray and the shape of the combustion space are so designed and inter-related that the combustion chamber is filled with a uniformly distributed and finely divided oil mist which burns completely without leaving any solid residue whatever. In an overload test run on a twin cylinder 17 x 27½ solid-injection engine rated 200 hp. at 200 r.p.m., the engine carried a load of 250 hp. (or 25 per cent overload) with no trace of smoke or color in the exhaust gases, and only when the load was increased to 260 hp. (or 30 per cent overload) did the exhaust start to become smoky. A detailed record of this test is given in Table II.

Further proof of the clean combustion that comes with properly designed solid-injection engines is pre-

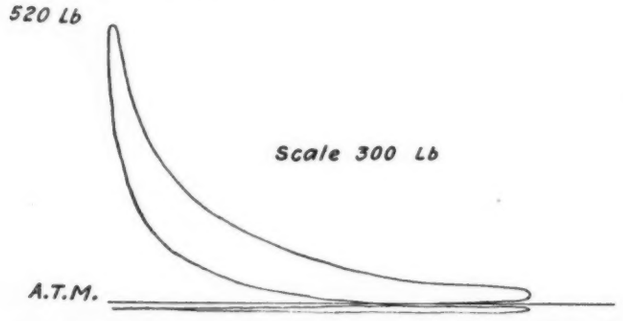


FIG. 3. TYPICAL INDICATOR CARD OF SOLID-INJECTION OIL ENGINE

sented by the inspection of the combustion spaces of engines that have run for many months under heavy loads. If "cracking" of the oil did occur, with resulting incomplete combustion, not only would the exhaust

TABLE I. FUEL-CONSUMPTION TEST ON 200-HP. SOLID INJECTION OIL ENGINE

Engine Data

200-hp. De La Vergne Type SI Engine.
Two cylinders, 17-in. dia. x 27½-in. stroke, 200 r.p.m.
Compression pressure cyl. No. 1, 322 lb. per sq.in.
cyl. No. 2, 318 lb. per sq.in.
Max. cyl. pressure at full load Cyl. No. 1, 540 lb. per sq.in.
Cyl. No. 2, 545 lb. per sq.in.

Test Data

Date of test—Oct. 5, 1920. Fuel—24 deg. B.É. fuel oil.

Per Cent Load	Brake, Hp.	R.p.m.	Fuel Consumption
10 per cent overload	220	200	0.421 lb. per b.hp./hr.
Full load	200	200	0.420 lb. per b.hp./hr.
75 per cent load	151	202	0.410 lb. per b.hp./hr.
50 per cent load	101	204	0.458 lb. per b.hp./hr.

have been smoky, but carbon deposits would have formed on the walls of the combustion space. Invariably, however, it has been found that these walls have collected no carbon deposits whatever.

Many of the other criticisms of the solid-injection engine advanced in the previous article, such as "after burning," "spray dripping," etc., are more fanciful than real. The phenomena of the combustion of fuel within an engine cylinder are extremely involved and are not nearly well enough understood to permit positive deductions to be drawn by purely theoretical methods. Consequently, abstract theorizing cannot be accepted unless verified by actual test.

"After burning," if it existed, would result in a high fuel consumption and this, as we have seen from the test reports previously quoted, does not occur. The tests show that a solid-injection engine is not any more susceptible to "after burning" than any good Diesel engine.

"Spray dripping," is referred to in the previous article in connection with the statement that "the action of a pump is by no means as rapid as a needle valve.

TABLE II. COLOR OF EXHAUST

Test on 200-hp. De La Vergne Type SI engine.
Twin-cylinder, 17 in. x 27½ in., 200 r.p.m.

	Hp.	
50 per cent load	100	Exhaust clear
75 per cent load	150	Exhaust clear
Full load	200	Exhaust clear
10 per cent overload	220	Exhaust clear
20 per cent overload	240	Exhaust clear
25 per cent overload	250	Exhaust clear
30 per cent overload	260	Exhaust started to show color

The cessation of the oil spray into the cylinder is necessarily slow, and the lines may continue to leak." If this occurred, the oil pressure at the end of the injection would be lower than normal and the final portion of oil would be introduced into the cylinder in the form of fairly large drops instead of a finely divided spray. Such drops would not burn completely and would form carbon deposits which would have a tendency to build up in the combustion chamber directly under the spray nozzle. Such carbon deposits did actually occur fifteen years ago when the low-compression hot-bulb type of oil engine—for example, the Hornsby-Akroyd engine—was being developed, and were the result of imperfectly designed fuel pumps and spray valves. In modern solid-injection engines this action never occurs and the combustion space close to the spray valve is as clean as elsewhere.

The preceding part of this article has been devoted to a contradiction of several criticisms made in error against the solid-injection engine. However, if this engine merely had the negative virtue of not being so bad as it is claimed, there would be nothing to justify its rapidly growing importance in the field of efficient prime movers. On the contrary, the solid-injection engine has many real and vital advantages, the value of which are being recognized more and more as engineers are becoming acquainted with them. This type of engine has the same good points as the Diesel engine—namely, high fuel economy with a wide range of oils, immediate starting, no stand-by losses, etc.—and has besides, the following advantages:

1. The air compressor is eliminated with all air valves, pistons, connecting rod, crank and high-pressure air pipes. The air compressor and its attendant mechanism, which is an inherent part of all Diesel engines, is by far the most troublesome feature of the engine. The elimination of these parts results in a great gain in simplicity and ease of maintenance. Not only is the reliability of the engine increased and the cost of maintenance reduced, but about 10 per cent of the total power is saved and made available for useful work.

2. In addition to the elimination of the air compressor, the mechanically operated spray valve is done away with and replaced by a simple spray nozzle with no external moving parts. This eliminates the cam and linkage required with the Diesel spray valve and also does away with the high-pressure stuffing box, as the solid-injection spray valve has no stuffing box at all.

3. The mechanical efficiency of the engine is improved by eliminating the power loss in the air compressor and this results in lower average cylinder pressures for the same brake load.

4. Lower air pressure can be used for starting. On account of the compression pressure being 100 to 150 lb. less than that on the Diesel engine.

How To Correct for Error in Instrument Voltage Transformers

Regulation of Voltage Transformers—Usual Practice in Transformer Connections—Phase Angle and Change in Ratio of Transformation-Problem Worked Out, Showing How Wattmeter Readings Are Affected by Transformer Error

By J. B. GIBBS
Transformer Engineer, Westinghouse Electric and Manufacturing Company

VOLTAGE transformers are used in the measurement of high voltages for two reasons: First, because it would be dangerous to handle circuits of these voltages; and second, no meter designed for such voltages could compare in accuracy and cost with the standard low-voltage instruments. These transformers are usually of small capacity, since the only load which they are expected to carry is a few instruments. They are designed for extra good regulation, so that the secondary voltage shall bear as nearly as possible a fixed relation to the primary voltage under all conditions of load. It is impossible to get exactly correct ratio and phase angle at all loads because of the iron and copper losses that are always present in transformers. In good voltage transformers, however, the errors are small—a fraction of one per cent in ratio, and considerably under a degree in phase angle. In addition to this the transformer is "compensated" so as to give correct ratio at the load that it is expected to carry.

These transformers are made for circuits of all voltages and are used with voltmeters, wattmeters, watt-hour meters, relays, etc. Several instruments may be connected to the same transformer provided their combined load does not exceed the load for which the transformer was designed. In single-phase systems one voltage transformer is needed for each circuit that is to be measured independently, and a switching device is

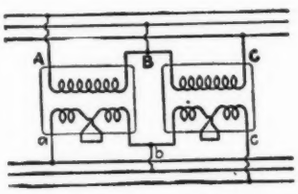


FIG. 1. OPEN-DELTA TRANSFORMER CONNECTION

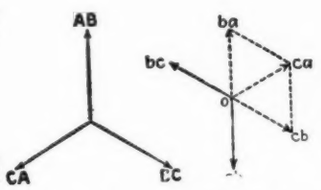


FIG. 2. VECTOR DIAGRAM OF VOLTAGES IN FIG. 1

usually provided so that one voltmeter may be connected to any one of the transformers. Two-phase systems are the same as two single-phase systems. In three-phase circuits, three voltage transformers may be used connected in delta or in star, but the usual practice is to use two transformers connected in open delta. The latter gives the voltage of all three phases, saves the cost of one transformer, and the error which it introduces is extremely small. The connection is the same as for power transformers and is shown in Fig. 1. Why the voltage across the open phase corresponds to the voltage between lines *A* and *C* is shown in the vector diagram, Fig. 2. *AB* represents the primary line voltage from *A* to *B*; *BC* that from *B* to *C*; and *CA* that from *C* to *A*. In the secondary windings of the two transformers voltages will be induced opposite to the corresponding primary voltages, and these are representated by *ab* and *bc* respectively. Now the voltage from *c* to *a*, Fig. 1, will be the vector sum of the voltage from *c* to *b* plus the voltage from *b* to *a*, and these voltages will be represented in the diagram by vectors opposite in direction to *bc* and *ab* respectively. These are shown by dotted lines in the diagram, and their resultant is *ca*, which is the same length as *ab* and *bc*, and which lies 120 deg. from each of them. This is the same as saying that *ca* is opposite to *CA* in phase and proportional to it in length, which is the condition desired. Iron and copper losses in the transformer not only cause a small change in the ratio of transformation as the instrument load is increased, but they also cause a small shift in the position of the secondary voltage with respect to the primary voltage. For instruments that measure voltage only, such as voltmeters and certain relays, the phase angle is of no importance; but for wattmeters, and especially for watt-hour meters, it may make an appreciable difference when very accurate measurements are needed. Suppose that *E* and *I*, Fig. 3, represent the voltage and current in a certain circuit. The true power in the circuit, then, will be

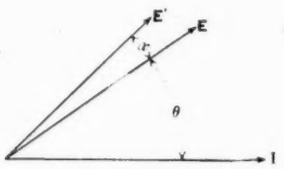


FIG. 3. CURRENT AND VOLTAGE RELATIONS IN VOLTAGE TRANSFORMER

$$P = E \times I \times \cos \theta$$

But it is necessary to use a voltage transformer which delivers a reversed secondary voltage of *E'*, which is slightly smaller than *E* and slightly out of phase with it. The wattmeter reading, therefore, will be

$$R = E \times I \times \cos (\theta + \alpha)$$

The true power in the circuit is found from the wattmeter reading by means of the expression

$$P = R \times k \times \frac{\cos \theta}{\cos (\theta + \alpha)}$$

where

P = True power;
R = Wattmeter reading,
k = ratio of E to E'. This is the same as "per cent ratio" in the calibration curves of the voltage transformer;
θ = Phase angle between E and I, in the main circuit; that is,
$\cos \theta$ = Power factor of the main circuit;
α = Angle by which E' leads E. This is found for the particular load from the calibration curve.

Example: What is the true power when the wattmeter shows 875 kw., the voltmeter 2,300 volts, and the ammeter 500 amperes? A voltage tranformer is in use having the characteristics shown in Fig. 4, and the load on the voltage transformer is 40 volt-amperes at 80 per cent power factor.

Solution: From the curves for 80 per cent power factor, at 40 volt-amperes load, $k = 100.2$ per cent and $\alpha = 11$ min. leading, as indicated by the dotted lines on the chart, Fig. 4. The power factor of the circuit is

$$\frac{watts}{volts \times amperes} = \frac{875{,}000}{2300 \times 500} = 0.761 = \cos \theta \, (approx).$$

Therefore $\theta = 40$ *deg.* 32 *min. and* 9 *sec.*

$\theta + \alpha = 40$ *deg.* 32 *min. and* 9 *sec.* $+ 11$ *min.* $=$ 40 *deg.* 43 *min. and* 9 *sec.*

$\cos(\alpha + \theta) = 0.7579$

Therefore $P = 875 \times 1.002 \times \frac{0.761}{0.758} = 880.3$ kilowatts.

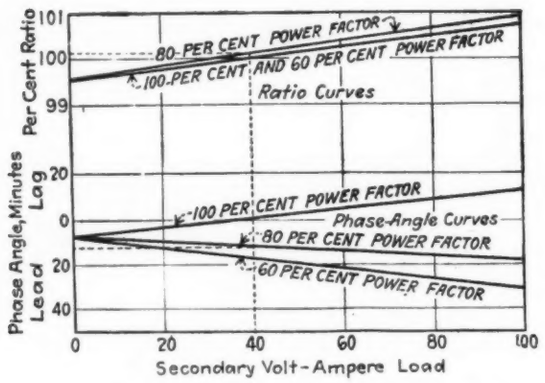


FIG. 4. VOLTAGE-TRANSFORMER RATIO AND PHASE-ANGLE CURVES

It will thus be seen that for the figures assumed, the error due to the voltage transformer is 5.3 in a total of 880, or about 0.6 of one per cent, which is less than the error of the wattmeter. In general, errors due to well-designed voltage transformers may safely be neglected except in accurate laboratory measurements.

The manufacturer will usually supply to purchasers on request "typical curves" of ratio and phase angle for the class of instrument transformer purchased. These represent the performance of any individual transformer of the class very closely, say, within one-half of one per cent, and are sufficient for everything except the most accurate laboratory measurements. Where the highest possible accuracy is required, ratio and phase-angle curves should be used for the individual transformer in use. These require special testing, and a charge is usually made for them.

Economic Value of Coal—IV. Impurities in Coal

By B. S. MURPHY

As the function of coal in a power station is to produce heat, any substance in or on coal that will not give heat in the reaction of combustion is an impurity. The most economical coal is, then, one containing the minimum of impurities.

IMPURITIES in coal at the best are inert and are therefore a dead loss, as they occupy space that belongs to the carbon and for this reason reduce the heat content. In reality the impurities are rarely inert, so at their worst they will form slag or clinker and so insulate from heat, or block off the free passage of air which is required for the supporting of combustion, as to retard the reaction of the remaining, or carbon, portion of the fuel. Ordinarily, they are between these two, and every coal will vary; even the same coal will vary in operating results, depending on the furnace and other boiler conditions.

A chemical analysis of coal for the impurities, or the so-called ash, only gives an indication as to what may be expected under conditions of actual operation; the true test is the burning of the coal on the grates under a boiler, and the measure of the result is the proportionate amount of furnace refuse as compared to the coal as fired. Such a figure takes into account the unconsumed carbon in the ash, for if the impurities will prevent the burning of all the carbon, this carbon itself will add just that much to the furnace refuse, and such a test will also give the kind of ash as clinker, swelling, etc. In this latter connection determinations of the fusing point by laboratory tests is extremely useful, but will not exactly prophesy the coal's behavior in the boiler furnace. However, it is rarely possible to burn under operating conditions each new coal that is offered; so, from other performances with coal of similar characteristics as shown by laboratory analysis, we must base our discussion as to what may be expected in practice.

Two Classes of Impurities

Broadly speaking, we can divide the impurities into two classes—that on and that in the coal. In the former division, under most conditions, we can say that these impurities are dirt and water. The dirt may come from the method of mining, lack of treatment after mining or method of storing, and the water from rain or snow in storage or transit, and if the haul is very short, water from the washing. An excessive amount of water on the surface of coal may be beneficial and at times may be necessary, but as this water has to have heat applied to it to drive it off, it is an impurity. As an extreme case of water being a harmful impurity, an instance may be cited where a leader from the roof-drainage system of a power station came adrift through the coal bunkers during a heavy rainstorm. The result was the deadening and finally the extinguishing of the fire in the particular boiler whose chute was nearest to this broken leader. The surface dirt may come from mining methods where care is not taken in the picking and washing or from storage of yard coal at the power station, and, in fact, this latter is often due to storage in some muddy location or against higher ground where the run-off, carrying large amounts of suspended matter, flows through the storage coals and deposits this mud. And at times, if such a deposit as this is not removed

before using the coal, it may be a very positive detri ment.

Unfortunately, the external impurities on the coal cannot be regulated by the consumer, as he has no control over the mine, and if proper care in mining is not exercised or in the treatment between the mining and the tipple, an excellent coal may be worthless, owing to the great amount of foreign matter, causing low calorific value as fired and operating difficulties in the furnace itself. From the consumer's viewpoint it is immaterial whether the impurities exist in the coal itself, on the surface of the coal or in the mass of the fuel, as he has but little opportunity to separate them. He purchases the fuel, and it must be utilized as received.

For all ordinary purposes a proximate analysis is all that is required for a day-to-day record of the fuel; this, of course, will tell the sulphur, volatile matter, fixed carbon, incombustible reported as ash, moisture and calorific value. For a new coal a complete analysis is extremely useful if not imperative, but this requires more labor and time, and for ordinary routine is not necessary. Among the most valuable data is the fusing point of the ash, but here again too much dependence may not be placed on this alone, for an ash may have a fusing temperature by test apparently high enough to prevent trouble, but when in contact with the furnace refractory may fuse and stick at a much lower temperature.

In this connection it might be mentioned that a certain anthracite gave excellent results under hand-fired boilers at from 75 per cent to 100 per cent rating, but when used on stokers it was too uncertain in its behavior to be trusted. One day it would apparently give fair results, but the next day it would fuse so badly as to shut off the draft. In other words, it was being used at its critical temperature, and one day, or at least one peak hour, where the boilers did not have quite the demand and the fires were not forced so much, the temperature was relatively low, so there was no fusing, while a slightly greater demand, necessitating greater rating and higher temperature, caused the fusing.

A coal high in sulphur is, of course, to be avoided because of its clinkering tendency; the limit will vary with other plant-operating conditions and the coal itself. But for economic results it is good practice to avoid any high-sulphur coal.

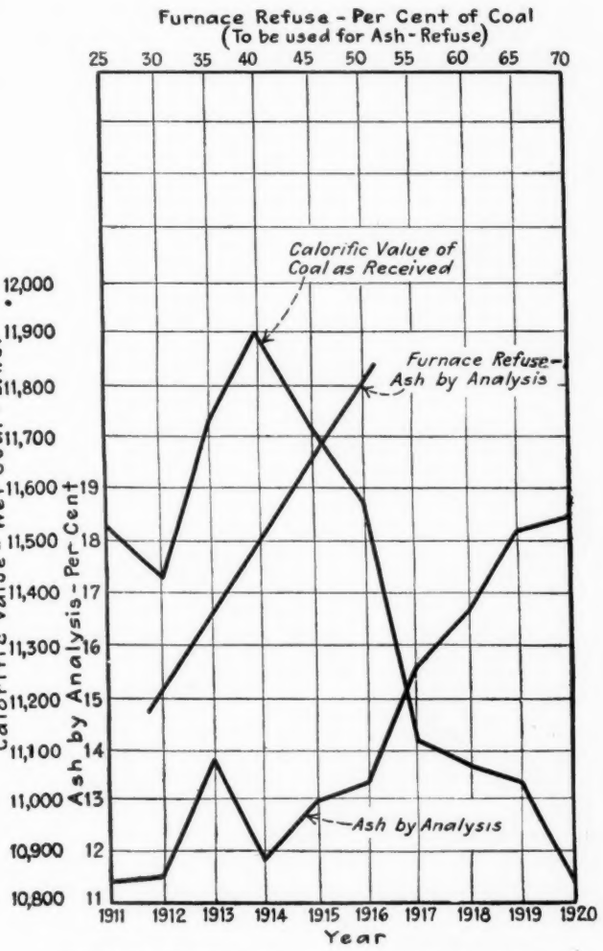
In order to harmonize the burning or operating characteristics of the fuel with the laboratory analysis, a large anthracite station made it a practice to have the boiler-room foreman classify each day the visual appearance of the coal during combustion before he was informed of the laboratory results. This was done by a series of symbols to represent the burning quality, swelling and fusing, and this information, in connection with the laboratory data, was found to be extremely useful in the purchase of different coals and at the same time shows what can be expected from the boilers, for it is manifestly unfair to expect the same boiler output and capacity irrespective of the adaptitude of the particular fuel to the operating conditions.

Rapid Increase of Ash in Coal

In order to show how rapidly the incombustible in the coal has increased for the last few years, the laboratory analyses have been plotted for anthracite received at a certain power station from 1911 to 1920. This shows a very rapid increase from 1914 to date. On this same curve has been plotted the average calorific value for this coal as received, and this shows the corresponding falling off in the calorific value with the increase in the combustible, as would be expected.

Effect of Impurities in Coal

In hand-fired boilers the increase in the impurities is more noticeable than with stokers, and as a general rule stokers will burn economically a coal that will be absolutely unsuited for hand fires. In hand fires the impurities affect the firemen themselves to a very great extent, as much more coal has to be handled and a very



FURNACE REFUSE AND ASH IN ANTHRACITE

much greater volume of ash has to be removed; and though four or five years ago it was possible to get the average fireman to take a pride and interest in his work and try to overcome such difficulties, this condition has passed to a large extent, and on account of the additional labor involved, it is becoming more and more difficult to procure men of the right caliber to do this laborious work. Also, it tells on the boiler capacity with hand fires to a much greater extent than with stokers. A fire will go just so long between cleanings—the less the impurity content the greater the interval—and then it must be cleaned, and of necessity, during the cleaning process the boiler will practically stop making steam, and unless this cleaning can be done at off hours of the load, it will necessitate additional boilers on the line to carry the same load.

As an instance of this, in a large railway station that was hand-fired with anthracite, the peak periods ex-

tended for 90 minutes in the morning and evening. At that time, with coal containing ash of from 12.5 per cent to 13.5 per cent, the fires were all cleaned before the start of the heavy demand period, and they would carry through for about two hours before becoming so heavy that cleaning was necessary. The impurities in the coal increased to 15.5 per cent on the average and on certain days as high as 20 per cent. As before, the fires were cleaned previous to the start of the load, and after most careful nursing, within from 45 to 65 minutes the fires would become so thick that there have been times where actually we had to pull out some of the ash and coal through the firing doors to make room for enough green coal to carry through the peak period even with two additional boilers on the line. In this case it was absolutely necessary to abandon the hand-firing and go to stokers, irrespective of any saving that could be anticipated and that was actually had by the installation of the mechanical grates.

With stokers the impurities are not quite so noticeable in the fireroom, as the great increase in hand labor is not required, but of course, as the ash goes up, more boilers will have to be placed on the line to get the heat required. More coal must be burned, and even attempting to increase the rating will not be enough, for with the high ash coal you cannot burn enough coal on your grates or in your retorts to generate the heat required.

Calorific Value and Relative Plant Economy

In the chart shown in the second of these articles (page 937, Dec. 14 issue) were plotted two curves to show the relation between the calorific value and the ash for No. 3 buckwheat coal. One was from results found at a certain power station and the other from data of the United States Bureau of Mines. It will be noticed that these curves agree quite well and show that for 29 per cent ash the calorific value is between 9,000 and 10,000 B.t.u. On this same graph was plotted the relation between the calorific value and the relative plant economy, and the calorific value curve and the ash curve are near enough to being parallel so that the relative plant economy may be read directly from the ash curve; this shows that the limit is reached when we approach 30 per cent of ash by analysis. Of course, for existing plants the limit is much below this, for even disregarding the additional cost for fuel, the plant having about 22 per cent of ash is operating at only 50 per cent of its economy and about the same in capacity.

The larger part of this loss in economy is due to the absence of heat in the fuel, but the ash itself has a very great effect in addition to the clinker formation. If there is a large volume of ash, the carbon particles become smothered, or if the ash is a sticky one, these particles become coated with this insulator and a large percentage of unconsumed carbon or incombustible in the ash results.

In the accompanying chart is plotted the relation between the furnace refuse, including soot, for No. 3 anthracite with stokers and high ratings and the ash as found by laboratory analysis. It must be borne in mind that this is far from exact and must not be used for other stations except in a very general way. The reason for this is that the rating is the controlling feature next to the volume of ash in the combustible found in the refuse irrespective of the kind of coal when chain-grate stokers are used and, to a minor degree, with other types of stokers. And it is a loss that we must bear to get the desired work out of the boilers. Next, the behavior of the specific coal will have a very great influence in that a pasty ash will coat over and insulate the carbon, or a swelling ash will bury the carbon, and so on. Also, the curve is based, not on actual weights, but on volumes converted to weights by an average unit volume constant. This in itself will make quite a difference. For instance, some time ago in a certain station No. 1 buckwheat had to be used in place of the regular No. 3 buckwheat with hand fires. The ash from this No. 1 puffed up like so much popcorn, and though by analysis we found only 15 to 17 per cent against 18 to 19 per cent for the No. 3, volumetrically it made one-half more ash. Therefore this curve may be used in a general way only to show the relation between the ash by analysis and the actual refuse that has to be handled. For instance, for the 15.5 per cent by analysis, over 30 per cent of the weight of coal must be expected as refuse, while with 19 per cent nearly 43 per cent, or about half of the weight of the coal, is useless.

Unconsumed Combustible

This variation between the ash analysis and the furnace refuse is the unconsumed carbon in the refuse and soot. The combustible in the refuse is a very large item when using the poor grades of anthracite where the boilers are forced and will show great variations, depending on the coal itself as well as the boiler rating. This percentage may vary for a good anthracite under fairly normal conditions from 26 per cent to 50 per cent where there is a clinkering, swelling ash and high ratings. The use of chain-grate stokers also accounts for some increase in this, an increase that we have estimated may be about 1 per cent or slightly over, but is more than counterbalanced by the other advantages.

Now, returning to the hypothetical anthracite station, in 1911 to 1914 the ash by analysis averaged about 12 per cent, and we will assume that the refuse then would be about 20 per cent. The coal for this period would have averaged about 109,000 tons per annum, so it would have been necessary to provide for the removal of some 21,800 tons of refuse per year. In 1920 the ash was 18.4 per cent, making about 42 per cent refuse, or 45,780 tons (110 per cent) more. This will, of course, at least double the cost of removal and very likely make necessary additional capital charges for apparatus of increased capacity.

Semi-Diesel Engine Suggestions

If a semi-Diesel is operated with a low-temperature cooling water discharge, it usually smokes badly and will not carry its load. The engineer should experiment until he secures the temperature for best results.

With a wet or water injection engine if too much injection water is used the engine misses fire, the exhaust has a very heavy gray color and the hot bulb cools off.

If the water is insufficient, the engine will preignite at each revolution. If too much water, the engine sometimes misses a shot and preignites on the next stroke.

If a hand-operated air starter is used, a check valve should be placed between the engine cylinder and starting valve. Without a check valve the flame in the cylinder may blow back through the air line.

If the engine continues to preignite, the adjusting nut on the fuel injection pump can be screwed in, making the injection point occur later.

Refrigeration Study Course—XX Erection and Operation

By H. J. MACINTIRE
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IT IS not possible to give more than fundamental ideas in a short study course such as this is, and especially is this true of erection and operation. In the case of erection only general statements can be made of facts that are true of all makes and that are not affected by the detail design.

The main essentials in refrigeration are to make the system ammonia-tight, the valves so that they open properly with the least excess pressure necessary and close properly and promptly. Of course the valves must be ground to a tight seat. The compressor must be erected so that the reciprocating parts are central, for it is impossible to maintain tight rod packing otherwise. Adjustment should be made to give more clearance on the head end for the double-acting machine, because of the effect of friction on the length of the piston rod. It will be remembered that the operator can easily stall a compressor by tightening on the stuffing-box packing. The inclosed type of compressor, having no stuffing box but having the entire connecting rod exposed to the temperature of the suction gas, which is colder than the temperature of the air which prevailed during erection, should have no clearance. During operation the rod will cool and shorten.

The refrigerating system is an inclosed one and the plant will retain all impurities that are left in it when erected. In consequence care should be taken to make the inside as free from pipe threads, mill scale and dirt of all sorts as possible. Before erection each length of pipe should be cleaned, at least by hammering on one end. After testing with compressed air for leaks it is usual to open each coil or section of pipe directly to the atmosphere to blow the loose stuff out of the system.

The piping should be carefully erected. Ammonia is very difficult to keep tight, and special provision is always made to prevent leaks. This includes special (ammonia) fittings of dense, close-grained cast iron, steel castings and drop forgings. The piping should be wrought iron or steel, and the steel may be butt or lap welded in the smaller sizes, but only lap welded in sizes over 2 in. diameter. When steel pipe is used, it is wise to specify extra-heavy rather than full-weight, especially if the plant is troubled with corrosion due to galvanic action or stray electric currents.

Joints should be made up with litharge and glycerin (mixing up a little at a time as needed) or by the use of the sweated joint. The work done at the shop, such as condensers and other piping put up in stands, is preferably sweated—by tinning and then making a shrink fit with enough solder to fill the screw threads and the cup at the back of the fitting. The piping should be securely fastened and arranged without low spots where water, oil or mud will accumulate. Where low spots are necessary the piping should be arranged to drain to this spot and a trap should be placed there. It will assist in keeping the system free from impurities and will be handy during overhauling.

The trap for small plants may discharge into the atmosphere, but for larger plants it should be connected with other traps feeding into the regenerator. The regenerator should always be used in plants of any appreciable size. It is the only way that we have of keeping the ammonia alive and in good operating condition without the necessity of removing the charge and returning it to the manufacturers of ammonia for purification. A suction-line trap should be placed in

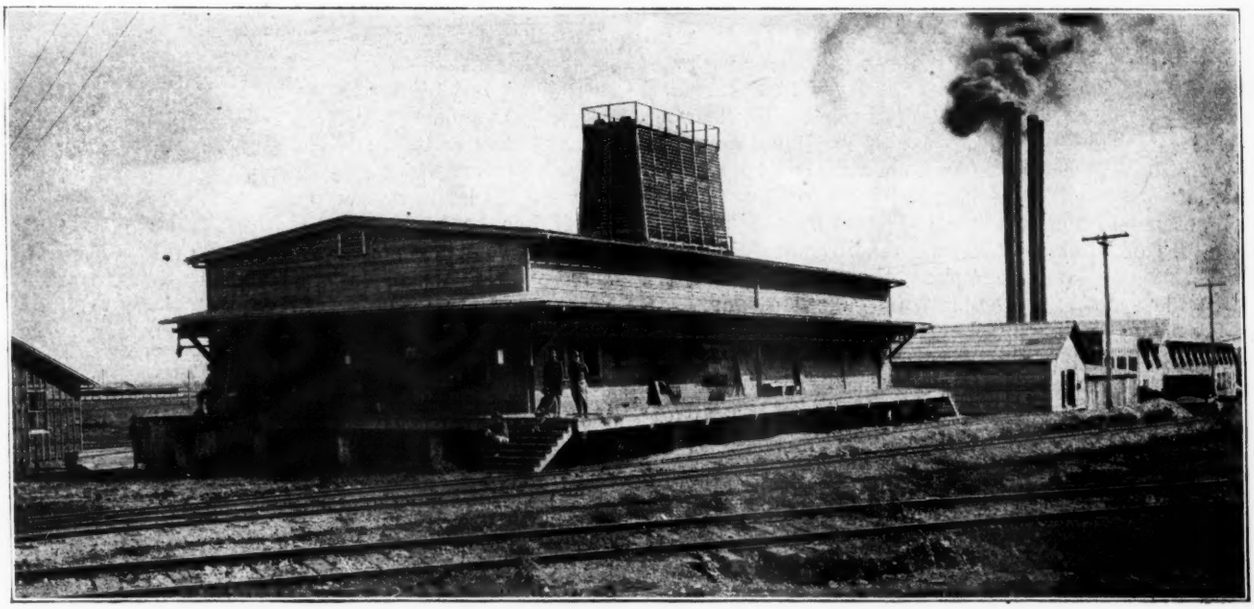


FIG. 1. REFRIGERATING PLANT BUILT AT CAMP TRAVIS DURING THE WAR

the pipe line near the compressor to prevent the passage of scale and other impurity into the compressor. This trap acts similarly to the steam-engine separator and will assist in preventing slugs of liquid ammonia entering the compressor during operation.

Discharge Receiver Should Not Be Placed Near Compressor

It is a mistake to place the discharge (oil) receiver too near the compressor. The receiver is most useful in removing oil from the discharge gas and will do so if the oil is in a liquid form and the velocity not too great. But frequently the temperature of discharge is excessive and some of the oil, particularly some grades of oil, is vaporized. The discharge line, being uncovered, will quickly lose its superheat and therefore the separator will be more likely to function properly if placed nearest the condenser. The temperature of discharge is important, and every compressor should be supplied with thermometers for the suction and the discharge pipe lines.

It is generally conceded that the most economical manner of operation is to bring the ammonia back to the compressor in a dry, saturated condition. Too much superheat of the return gas cuts down the capacity of the machine, and too wet a condition (wet compression) of the gas allows excessive re-expansion in the clearance volume as well as inefficient use of the liquid ammonia. By means of thermometers the operator can tell whether the suction gas is superheated by the reading of both temperatures, and whether it is wet by the low temperature of discharge. These readings are similar to those in the steam-power plant, the CO_2 apparatus, the steam-flow meter, the boiler-draft gage, etc., and are a ready means of showing changes in operating conditions, as just mentioned. The old method of trying to operate by placing one's hand on the pipe should be avoided, as it is hardly likely to lead to good results.

Operating Conditions

Reviewing the operating conditions which cause decreased capacity in plants, increased power input or inability to secure the required temperature, the main troubles are valve action, ammonia contamination, with inert gases in the condenser or water in the liquid receiver and the expansion coils, and scale, mud, oil and other pipe troubles in the condenser and the expansion coils.

The compressor is a pump, and as a pump it is necessary that the cylinder fill completely at each stroke with gas at the pressure of the expansion coils and discharge out of the cylinder at the pressure of the condenser. There must not be any "slip" of the valves or loss of gas past the piston rings, for otherwise the object of the compressor will not have been fulfilled, the purpose being to lift the maximum weight of gas from the suction or low-pressure side to the discharge or high-pressure side. Mill scale or other impurities are likely to work under the valves, and irregular wear or wiredrawing will cause leakage. This is also true of the piston rings and the cylinder. These cannot be neglected with the impunity with which the steam engine is run, but must be kept tight by constant care and attention. The steam engine has moist steam, which often will remain fairly tight under conditions that would be impossible in the refrigerating plant.

Inert gases in the condenser are not only bad because of the extra pressure against which the compressor has to pump, but also because of the decreased efficiency of the condenser containing them. As already explained, air, nitrogen and hydrogen in the condenser act as an insulator on the pipes, and it is possible for parts of the pipes in the stand to be put out of commission. Inert gases are mainly due to the presence of air and of decomposed lubricating oil. There is little decomposition of the ammonia at the usual operating conditions. Care should be taken not to operate at a vacuum at any time, unless very low temperatures are necessary, and even then a vacuum is not usual. The trouble with operating under a vacuum is that air will always get into the cylinder through the stuffing box, even though the packing is sufficiently tight to prevent the ammonia escaping into the atmosphere when the suction pressure is greater than the atmosphere. Lubricating oil should be selected for the two extremes of temperature, so that it will not freeze at the suction and disintegrate at the temperature of the discharge under the most severe operating conditions. Incidentally, the maximum temperature of the discharge gas is obtained when the suction pressure is the lowest combined with the highest condenser pressure. The condenser pressure should be compared frequently with that corresponding with the ammonia tables, using a temperature a few degrees higher than that of the exit condensing water. Any marked difference between these two pressures indicates that non-condensable gas is present in the condenser, which may be removed only by purging. But the reader is warned against too frequent purging, as it has been proved that the greater part of the ammonia lost in some plants is due to this cause. It is impossible to purge without allowing a large amount of ammonia to go out. Large plants have devices to reduce this loss to a minimum, by purging into water and distilling the ammonia out of the water, or by the refrigerated purge tank. The latter is simply a device to cool the gases being purged with refrigerated coils with the idea of condensing the ammonia out of the permanent gases.

Adding Oil to the System

Some engineers believe that after the first few months little or no oil should be added to the system, because, being a closed system, oil will travel around the cycle with the ammonia. This probably will work out right with careful attention to details by experienced engineers. The oil trap should be kept drained of oil at all times, and the condensers and the expansion system should have regular overhauling. As oil in the expansion line is likely to congeal, it is essential that proper means be used to get the oil to flow.

After pumping a vacuum on the cooling coils to free them of ammonia, heating the pipes if necessary, the coils should be drained and finally blown out with steam under pressure, giving a rather free exhaust so that the velocity of the steam will carry out the liquid and other soft deposit. After this steaming has been completed satisfactorily hot air should be pumped into the pipes to dry out any moisture remaining. Finally, in pumping a vacuum on the coils preliminary to recharging the system, the compressor should be slowly run. This is because with oil and air in the compressor there is needed only the proper mixture and the flash-point temperature to secure an explosion. This flash-point temperature is easily reached with vacuum pumps when one considers the very high range of pressures possible under the conditions.

Leaks in the system may occur at any point, and daily care is necessary to keep the plant tight. The piston rod is responsible for the greater part of the loss in the engine room, especially if the rod is not central in the gland. Ammonia test paper should always be on hand and used, and Nessler's solution should be available for periodic tests of the jacket water, the condenser water and the brine. The condenser can be leaking with a split pipe for weeks without giving visible signs of trouble. The operator should approach the matter with an open mind, and remember that conditions are different in a certain respect from those in the steam plant. In the case of steam the loss of 100 lb. through the stuffing boxes, flanges, etc., probably would be of slight moment. With ammonia it would cause a loss of about $30 and would be objectionable on account of the odor. And so, just as in the boiler plant, where continued care is necessary to prevent blowoff-valve leaks, leaky settings and air holes in the fuel bed, it is necessary to be always on the lookout to keep the refrigerating plant in good condition.

Boiling Temperature of Ammonia Variable Depending on Pressure

Unless the surrounding medium (air, brine, water, etc.,) is hot enough the ammonia will not boil. The ammonia boiling temperature is a variable, depending on the pressure to which it is exposed, just as in the case of the steam in the boiler or the steam in the steam pipe or the radiator. If a brine tank has brine at 14 deg. F. it will not be possible to boil ammonia at a pressure of 30 lb. gage because the boiling temperature of the ammonia at that pressure is slightly over 16 deg. F. This is not important where but one expansion valve is used, but most plants have a variety of conditions, including cold storage, ice making and possibly a sharp freezer. In these plants, if the suction pressure is not low enough to boil the ammonia in the coldest room, then the liquid feed to the coldest coils will not boil and so will accumulate and finally become flooded, and "lost" or "dead" ammonia is the result, combined with unsatisfactory operation. A condition such as has been mentioned is often found in the case of plants requiring a heavy load of short duration, like the chillroom of the packing plant or the dairy with its pasteurizing load, or even the plant which has to pull down the brine-tank temperature in the morning. Incidentally, it is wise to remember that at times it is possible to have a double suction, or to have one machine on the low-temperature and the other machines on the medium-temperature refrigeration. It is unwise to have to govern the conditions of the whole plant by the conditions prevailing in one room.

On the other hand, the operator should remember to keep the suction pressure as high as possible and still carry the load at the proper temperature. This is because the tonnage of the compressor drops off rapidly with a decrease of the suction pressure, and the horsepower per ton of refrigeration increases very greatly at the same time.

[*This article concludes the Study Course.*—Editor.]

Low air pressure will cause the Diesel to smoke badly. If the combustion is efficient, there will be no smoke out of the exhaust pipe with proper air pressure. If excessive air-injection pressure is carried, the efficiency is decreased and the engine tends to pound.

Power for Nothing

For some reason or other the reconstruction period in which we are struggling seems to stimulate the inventive ingenuity of perpetual-motion schemers to a remarkable extent, and it would be interesting to know whether the financial response is as general and hearty as it used to be years ago when similar opportunities for investment were offered.

A correspondent calls attention to the H. B. L. Wind Motor Co., of Davenport, Iowa, which in a neatly printed folder outlines one of the simplest get-rich-quick possibilities which have come to notice. In fact, after reading this description it would seem hardly surprising if we should eventually see old chimneys quoted in our trade and financial papers in the same way that old metals or other commodities are today.

While the pamphlet referred to does not go into detail in describing the invention, some of the statements contained in it are wonderfully enlightening. For instance, "It looks so simple that a first glance a man is inclined to say 'it can't be done.'" It would undoubtedly be cruel to comment on this statement that sometimes a first glance is as good as a last.

Another statement is, "Nothing is left of the old power plant but the smokestack," and this is the key to the entire principle involved, which, indeed, is simplicity

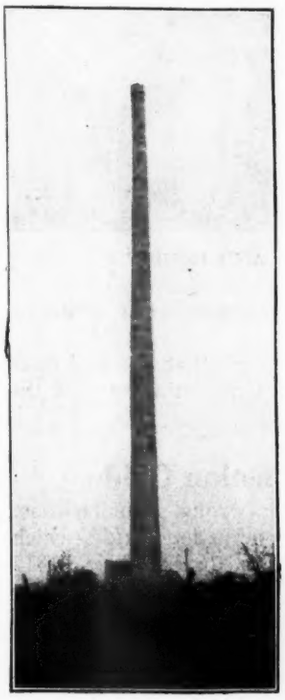


FIG. 1. THE SMOKESTACK

FIG. 2. A CLOSER VIEW

itself, for though the writer never realized before that the principle could be utilized in exactly this way, it is undoubtedly true that the pressure of the atmosphere at the level of the ground in ordinary locations used for power is somewhere around 15 lb. per. sq.in., while several hundred feet higher the pressure, of course, is a good deal less. What is simpler, then, than to build a high stack, as the H. B. L. people do, and by putting an air turbine in the bottom of the stack attain unlimited power from the turbine equipment owing to the draft that must go up the chimney?

The correspondent sent the three photographs reproduced here, showing very clearly the details of the construction referred to as applying to the experimental plant (somehow or other the perpetual-motion proposition never seems to evolve a plant No. 2), in which Fig. 1 shows the 250-ft. stack at a sufficient distance to get its entire length into the focus of the camera, Fig. 2 a nearer view of the base of the stack and the front of the shedlike structure housing the air turbine, and Fig. 3 the general arrangement of air turbine, shed and base of stack.

The correspondent also states that a recent test showed the power of the air turbine (eleven feet in diameter) to be 47 hp. at 80 r.p.m., and ends his letter with the following naïve statement: "I was fortunate enough to meet a man who happened to see the test, and he informed me that there was a brisk coke fire burning in the base of the stack during the run."

Quoting again from the H. B. L. pamphlet, "The Wind Motor is just what the name implies—a Wind Motor," and "it is our desire to keep this industry entirely in the

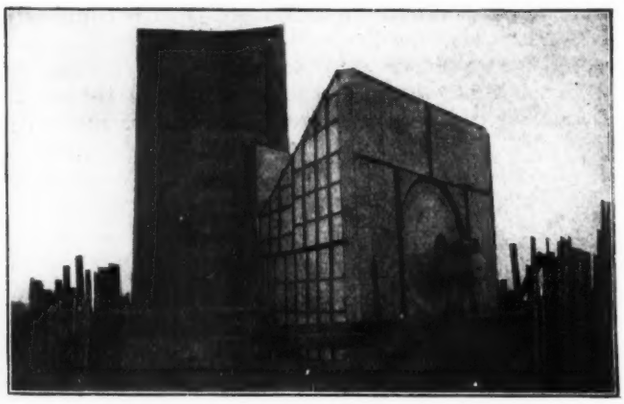


FIG. 3. AIR TURBINE AND HOUSING

Tri-Cities." Both of these statements are doubtless correct.

The Glee Club will now favor with that classical ditty entitled "And the wind blew up the chimney just the same."

"Producto" Combustion Guide

Meters and gages tell what is wrong in boiler-room practice, but the "Producto" Combustion Guide, which is manufactured by the Progress Products Co., 1313 Race St., Philadelphia, Pa., indicates what to do in boiler operation and damper control. Even with the best of firemen there is just as likely to be a large amount of excess air as there is to be the correct amount, which must be heated to the chimney temperature. This instrument indicates when the furnace fires are too thin or too thick and when there are holes in the fire. It combines the advantage of a steam-flow meter and a multiple differential draft gage. The body is cast iron, and the indicating tubes which are usually found in instruments embodying the idea of inclined liquid passages have been replaced by machined slots in the cast iron, which are covered by plate glass. The slots in which the liquids travel are white porcelained so that the levels are plainly visible.

The idea incorporated in this instrument involves the lining up of the steam-flow and the air-flow liquid levels for a given steam load with the boiler operating efficiently. For other efficient steaming conditions this alignment is maintained at various positions of the indicating liquid levels. Pressure differences, due to both steam and air flow, vary as the square root of the velocity. The other factors involved, although different, are constant for a given condition, and the differences

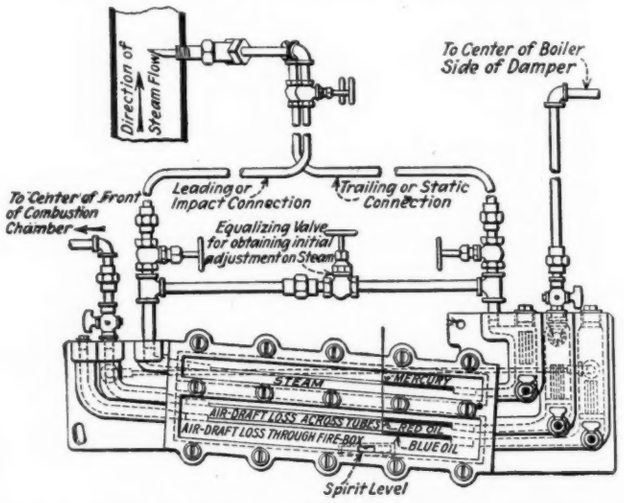

Direction of Steam Flow
To Center of Boiler Side of Damper
To Center of Front of Combustion Chamber
Leading or Impact Connection
Trailing or Static Connection
Equalizing Valve for obtaining initial adjustment on Steam
STEAM
AIR-DRAFT LOSS ACROSS TUBES
AIR-DRAFT LOSS THROUGH FIRE-BOX
RED OIL
BLUE OIL
Spirit Level

FIG. 1. COMBUSTION GUIDE AND PIPING ARRANGEMENT

are compensated for in the instrument by variable adjusting tubes, which, by controlling the areas in the liquid reservoir and consequently the relative movement of the different liquid levels, make the alignment a simple proposition. The liquid level in the upper tube moves in proportion to the steam flow; those in the lower tubes in proportion to either the quantity of air flow or to the change in resistance to flow through either the boiler tube or the fire bed. The method of reading the instrument is shown in Fig. 2.

The instrument is located on the boiler front level with the operator's eyes. For the steam indicator the nozzle-plug type of pilot tube is screwed into the steam main at any point more than two feet past a bend. All

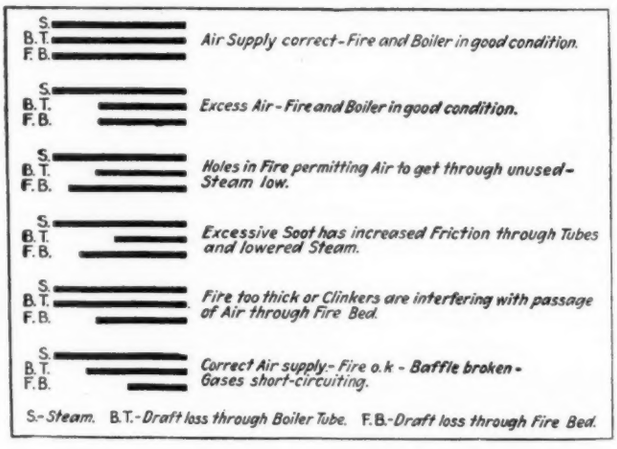

S.
B.T.
F.B.
Air Supply correct - Fire and Boiler in good condition.
Excess Air - Fire and Boiler in good condition.
Holes in Fire permitting Air to get through unused - Steam low.
Excessive Soot has increased Friction through Tubes and lowered Steam.
Fire too thick or Clinkers are interfering with passage of Air through Fire Bed.
Correct Air supply - Fire o.k - Baffle broken - Gases short-circuiting.
S.- Steam. B.T.- Draft loss through Boiler Tube. F.B.- Draft loss through Fire Bed.

FIG. 2. SHOWING METHOD OF READING THE INSTRUMENT

piping is ¼-in. except where it enters the boiler. To check the accuracy of the instrument, it is only necessary to open the equalizing valve and give the air cocks a half turn, thereby venting the pressures on all the liquid surfaces and bringing all the liquid levels to their initial positions.

The Application of Babbitt Metals

Practical Suggestions on Grooving, Alignment, Anchorage, Shrinkage and the Results of Casting the Metal When It Is Overheated

By L. D. STAPLIN
Manager Merit Metal Department, Great Western Smelting and Refining Company

MANY users of babbitt metal feel that it is only necessary to procure a good grade of metal and their bearing troubles will be over. This result does not always follow, as good metal, carelessly applied, means eventual trouble in most cases. For that reason the progressive consumer should make sure that his bearings are made slowly and with careful attention to detail. Because of their added service value, bearings made in this way will return the extra cost of this thoroughness many-fold.

In service, trouble is often occasioned by faulty alignment and grooving. In view of all that has been written on the subject, it seems strange that such should be the case, but it merely proves that bearing makers, as a rule, do not sufficiently realize the importance of these factors and sacrifice durability through lack of attention to them.

How To Do Good Grooving

The rules for good grooving are simple. Groove as little as possible and yet enough to distribute the lubricant evenly on the bearing's surface and particularly on that portion of the surface carrying the load, since an excess of grooving in the latter increases the pressure per unit of contact area.

All grooves should have rounded edges. Experience has taught the writer to look first for sharp corners on the grooves when trying to diagnose bearing trouble. A sharp edge left on a groove, as in Fig. 2, acts as a scraper and destroys the oil film. Round the edges as shown in Fig. 3, and the value of the lubricant is increased and the friction reduced.

When it is necessary to groove the load-carrying part of a two-part bearing, the following method has been found effective: with a boring tool or milling cutter remove the material from both edges of both halves of the bearing except for about half an inch at each end, as shown in Fig. 1, thus making an oil chamber about $\frac{1}{2}$ in. wide and $\frac{1}{8}$ in. deep on each side, then, at each end of the lower part only, cut a narrow groove parallel to the ends, connecting the two lengthwise recesses.

Alignment of Bearings

With sufficient patience any average mechanic can align a bearing correctly. It is only a question of willingness to take the necessary time to do a job in which it pays to be thorough. It is not enough to secure proper alignment when the bearing is made and then feel that the job is done. Before the bearing has run too long it should be examined, for in almost all cases readjustment will be found necessary because of unequal wear. If good alignment can be held, the best babbitt metal should be used on important heavy-pressure, high-speed bearings. If not, it is important to use an alloy adapted to the special conditions, having a plastic and yielding body, which will better conform to the contact surface.

Not many years ago the sale of the logging engines made by the largest iron works upon the Northwest Coast was hampered because the crankpin bearings became loose. Almost every known make of good babbitt metal was tried in an effort to find an alloy that would hold the bearings. The fault was so common that loggers objected to buying the engines. By request the writer followed two of the engines into the woods. When Sunday came, the crankpin brasses needed lining. Examination showed the simple fact that the anchors were too shallow to hold, because in service a logging

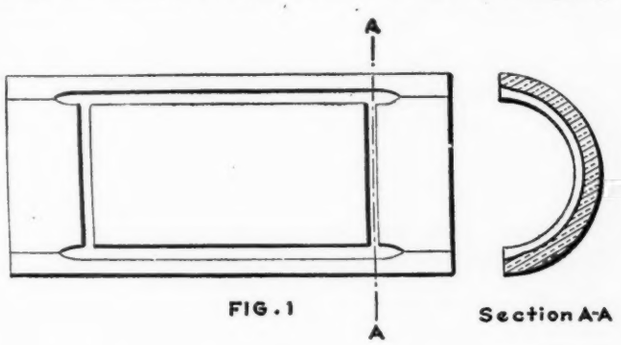


FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 1. GROOVING IN LOWER HALF OF TWO-PART BEARING. FIG. 2. GROOVE WITH SHARP EDGES, BAD. FIG. 3. GROOVE WITH ROUNDED EDGES, GOOD. FIG. 4. SHALLOW AND WEAK ANCHORAGE. FIG. 5. GOOD SOLID ANCHORAGE

engine crankpin brass is subject to extreme vibration. By making the anchorage deeper and using a little different style of anchor (see Figs. 4 and 5) the trouble was entirely remedied. The incident shows how simple seemingly serious bearing troubles frequently are. When trying to remedy loose liners, it will pay to examine the anchorage first.

If the service is at all severe, there should be close contact between the container and the liner. Even though the anchorage is right, experience may prove that soldering or tinning is desirable, and this can be done in the following manner, using a solder of 50 per cent tin and 50 per cent lead.

For tinning brass shells the first step is the removal of grease, dirt and other foreign matter from the shells by heating them, being careful not to overheat the material of the shell or the subsequent tinning will

*An article by the same author on "The Selection of Babbitt Metal" appeared in the Nov. 9, 1920, issue.

be difficult. A good way to remove oxide scale and to produce a good clean surface is to "pickle" the shells in a bath of water four parts and muriatic acid one part. In obstinate cases the most satisfactory way of preparing the shell for tinning is to machine or grind the surface to insure a clean metallic contact.

After cleaning, the surface is treated with zinc-chloride soldering solution and warmed either by plunging the shell into a quantity of melted babbitt metal or placing it over a fire. In the former case, a portion will adhere to the prepared face and can be spread over the surface later with a small brush, producing a mirror-like coating. In addition to this the hot face of the shell should be rubbed with a stick of solder and then brushed. This will give a good coating of solder on the prepared surface. If the shell is too hot, it will not take the solder well.

Tinning of steel shells may be accomplished in practically the same way, but care must be used in making the surface to be tinned perfectly clean and free from oil of any kind. Tinning of cast-iron shells is difficult ordinarily, but if sufficient care is taken to file the surface bright just before applying the solder, a good coating may be caused to adhere.

How to Prevent Shrinkage

Metals expand on heating and contract on cooling. There is shrinkage in every bearing metal. The hotter the metal when poured the more it expands and the more likely it is to make a lining that may not adhere solid and tight to the backing. This is because of the shrinkage in the metal when it solidifies, which may be sufficient to cause it to pull away from the backing, leaving a space into which the metal can be pressed beneath the load, thus possibly cracking the lining metal and causing it to break.

The commonly given instruction, "Heat mandrel and container whenever possible before casting," is the cause of more poor bearings than any other one common casting direction. It does not make so much difference if a low-grade bearing metal is cast while it is overheated, as its high content of lead prevents much change in structure during the cooling; but if a babbitt metal of the highest grade, such as carries a tin base and considerable content of copper, is cast while overheated, the service value of the metal will be greatly reduced. A good rule to follow where durability is desired, is to cast the metal at the lowest heat at which it will be fluid enough to flow into the bearing at one pour, and against surfaces that have been warmed only enough to remove the chill. If the container or mandrel sizzles when touched with a moistened finger, it is too hot. The more dense and solid the metal's structure, the greater will be its durability, and the foregoing principle, if applied (see Fig. 6), will produce bearings of the best value in density.

To Increase Density

It is desirable to increase the density when casting removable bearings, which may be done by immersing them in cold water as soon as the metal has solidified after casting. In doing this always be careful to immerse the casting from the bottom upward and do it slowly. The spot at which the metal is poured is always the hottest part of the casting and in cooling should enter the water last. This sudden cooling will close up the grain so that under the pressure and load of service it will not "pack" or "give."

Overheating will open the grain or coarsen the structure of babbitt metal. Since "grain" only means the distance between the particles that comprise the metal's structure, it follows that beneath sufficient pressure these particles will be packed together by the weight of the load upon the metal. This makes "clearance" equivalent to the same amount of wear.

This "packing" can be avoided if the metal is dense and solid, as it will be in ratio to its temperature when poured. Necessarily, the babbitt must be made hotter for a large than for a small casting, so heat according to the work in hand and do not be afraid to spoil a couple of castings in learning the lowest heat point. Experimentation in this connection will be repaid many-fold in the time saved in rebabbitting.

To illustrate a typical case of trouble caused by overheating a high-grade babbitt metal, the following experience will serve: The writer was called to the

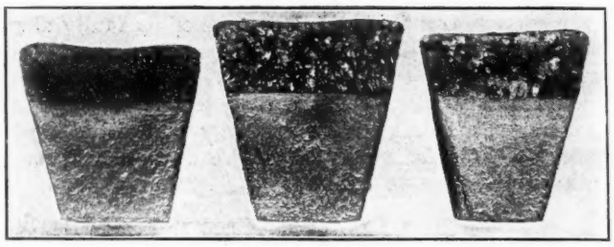


FIG. 6. STRUCTURE OF BABBITT METAL WHEN CAST AT PROPER TEMPERATURE, WHEN SLIGHTLY OVERHEATED AND WHEN GREATLY OVERHEATED

mill of a sugar manufacturer having trouble with centrifugal bearings. Examination showed that some would run a full season and others in the same type of machine and made from the same metal would last only a few days. After running a few days, the metal started to slough out of the bearing. By examining one of these bearings with a glass, the metal was found to contain minute cracks which would enlarge and finally cause the metal to give way under the vibration of service. The cracks were caused by contraction of the metal while cooling, after overheating and casting against a mandrel that was too warm.

If a lead-based, moderate-priced babbitt such as is so widely used for general work is poured when overheated or against an overheated mandrel, the results, as previously explained, are not so serious. Babbitts of this class are not likely to be "ladle spoiled," and to this good point they owe considerable of their popularity. However, overheating will make them brittle and more likely to break, crack or crumble beneath heavy loads and high speeds.

A steel company was testing a certain alloy in its rolls. Two bearings were cast with the metal nearly red when poured. At the end of five days the liner was $\frac{3}{32}$ in. thinner than when the test started. It had packed that much beneath the load. The two bearings were then cast at the proper temperature, and after running for twelve days they were tested and found within a trifle less than $\frac{1}{32}$ in. of their original thickness. It was customary to reline these bearings when the liners had worn to a certain thickness; hence, by casting the metal with care, the company was able to put more tonnage through the rolls that were correctly babbitted, with a saving of time, money and annoyance.

Some Distribution Cable Experiences

Industrial-Plant Load May Increase to Where Underground Cables Are Dangerously Overloaded Without It Being Realized—In One Case Temperatures Were so High That the Duct Walls Were Softened—Method of Cleaning Out Duct Described

By T. H. ARNOLD

PLACING the distribution cables underground in a duct system is frequently an excellent solution to the industrial-plant transmission problem, but like everything else it should receive adequate attention from the operating crews. In many cases where factory buildings are compactly arranged and overhead transmission wires are objectionable, it becomes necessary to place the feeder cables underground. Low maintenance costs may be expected from an installation of this class if properly installed. Unsuspected dangerous conditions may, however, exist unless the cable system is periodically inspected. In this respect, as in the matter of ventilation and cable changes, the tunnel system offers some advantages over the duct system, for a large installation. When proper inspections are regularly made, hot cables or other unusual conditions are noticed before they become dangerous.

A factory transmission system is usually composed of a number of large low-voltage cables carrying heavy currents. Plant growth is ordinarily evidenced by the gradual addition of a motor here and there throughout the various departments. These increases may not be noticed as long as the cables give no trouble. In a large duct system of comparatively short length a cable will heat beyond the safe operating temperature before the voltage drop becomes a serious factor. A cable will frequently heat to a dangerous temperature in a duct

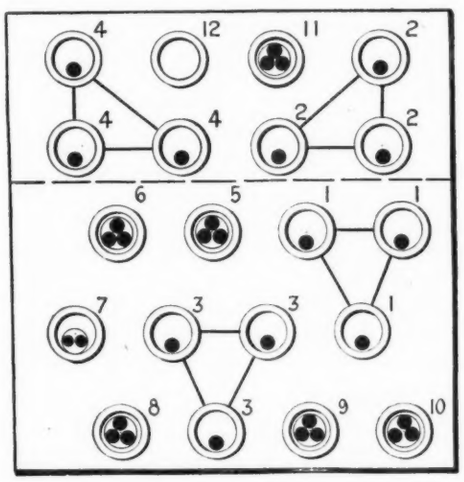


FIG. 1. DUCT AND CABLE ARRANGEMENT

system while carrying a current that would be perfectly safe in an isolated duct; also, it may be damaged if exposed to excessive temperatures from cables in adjacent ducts. This form of deterioration is more or less gradual and first affects the cables near the center of the run as the heat dissipation is less at that point. The nature of the ground, depth below surface, and the number and location of the ducts all have a distinct bearing on the heating of the entire system.

A recent investigation of a cable system was made for the purpose of determining what additions to the cables would be necessary to carry a contemplated increase in load. The system was designed for 1,500 kw. at 440 volts and was carrying an average in the neighborhood of 2,000 kw. The power factor in some departments was also somewhat less than that used in the original calculations. As no trouble had been traced

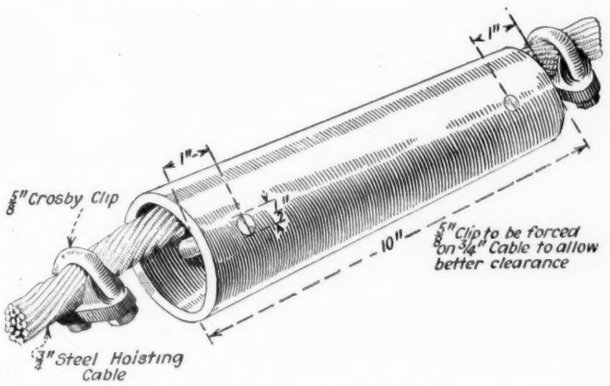


FIG. 2. DUCT CLEANER MADE FROM 2-IN. PIPE

to the cable system, it was assumed that with some minor changes the cables were adequate for the existing condition.

The power plant could not possibly carry all the motors on all the circuits at any one time, nevertheless there were times when all the motors on one circuit were running at full load for a sufficient time to heat the cables. In the table are shown the rated motor load on each feeder and the size of the conductor. The manufacturing plant was operated to get the greatest output with the power available, and thus the average load carried was very close to the rated capacity of the generators. As this was a twenty-four-hour load, the cables had no opportunity to cool.

A thorough examination revealed some rather startling conditions. The manholes had been sealed to prevent the admission of water, and when opened, the interior temperature was found to be very high. The cables were paper-insulated, lead-covered, single- and three-conductor, insulated for 2,500 volts. In two manholes the lead and paper were burned completely off some of the cables, leaving them bare, and from their appearance they had been in that condition for some time. No definite date could be assigned, but from some circumstances that could not be explained at the time, it appeared likely that the burnouts had occurred about three years previously. As the interruptions were only temporary, no search was made for the cause and the cables were operated in that condition.

The duct material was of the familiar bituminous fiber or paper composition laid in concrete with the general arrangement as shown in Fig. 1. At some

points the duct material had softened and completely closed the ducts. A laboratory test showed that the duct material softened at about 140 deg. C., which is sufficiently above the safe operating temperature of the cables to be satisfactory.

One cable that was removed was found to be in very bad shape in spots. The insulation was charred to a chocolate brown and the filler compound completely dried out.

In some cases where the bond wires had been removed, pitting of the lead sheath was noted. The individual cables were in no case carrying in excess of the underwriters' rating for this class of insulation and had been thought to be in a safe operating condition. The only insulation breakdowns experienced were the ones mentioned in the foregoing, but had the voltage been higher, they would have been more numerous.

In remedying these conditions, some of the old cables were removed and larger ones installed. This work was considerably delayed by the softening of the conduit and the temperature of the ducts and cables. Where the duct was in good shape, the rods invariably came out too hot to handle without gloves. It developed that where the conduit ran close to the surface of the ground little trouble was encountered, but where it was buried

FEEDER CABLES AND LOADING

No.	Dept.	No. of Cables	Conductors per Cable	Cable Size	Connected Load; Rated, Hp.
1	A	3	1	1,600,000	1,010
2	A	3	1	1,000,000	....
3	B	3	1	1,000,000	1,100
4	B	3	1	1,000,000	....
5	C	1	3	400,000	163
6	Lighting	1	3	No. 2/0	50
7	Direct Current	1	2	250,000	25
8	D	1	3	450,000	265
9	E	1	3	No. 1/0	105
10	F	1	3	300,000	245
	G	1	3	No. 1/0	132
12	Vacant	...	...	.....	....

The numbers in the first column correspond with the duct diagram.

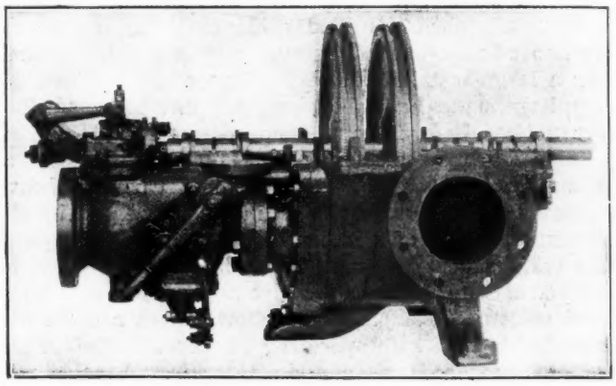
six feet or more the temperature was very high and the duct softened. Where possible the duct was dug up and repaired, otherwise it was cleaned out and the cable pulled through the remaining hole in the concrete.

The cleaning was a slow and laborious process, and sometimes after a section was apparently clear the material seemed to cave and fill the opening again. Lengths of ¾-in. pipe suitable for handling in the manholes were started in the duct and screwed together till they reached the obstruction; they were then driven in about six inches, removed, cleaned and returned to the hole. In this manner a hole was finally driven through. The rods were then passed through and followed with a piece of old ¾-in. steel hoisting cable on which were fastened a number of Crosby clips at intervals of two feet. This was pulled back and forth till no more material was brought out by the Crosbys. They were then removed and replaced by the pipe scraper, Fig. 2. This scraper was made of a 10-in. piece of 2-in wrought-iron pipe and was placed on the cable and secured by a clip on each side. The scraper was pulled in till a stress of ten or fifteen tons was exerted on the rope. It was then pulled out, the material cleaned from the interior and returned. Sometimes it took as much pressure to pull the scraper out as it did to pull it in, owing to the material caving in behind. When the cables were pulled in they went fairly easily. The head of the cable frequently brought out large masses of the duct material. No signs of damage were noted due to the lead dragging on the bare concrete.

New Steam Turbine for Mechanical Service

A new steam turbine of either one, two or three stages for driving centrifugal pumps, blowers, etc., has recently been designed and may be arranged to operate at steam pressures of from 50 to 300 lb. with or without superheat, and either non-condensing or condensing. It is, in general, adapted to supplying an output anywhere from 10 to 400 hp. at 1,000 to 5,000 revolutions per minute. It is manufactured by the General Electric Co., Schenectady, N. Y.

The illustration shows a two-stage turbine with speed governor mounted on one end of the shaft. The connections between the governor and governor valve are shown at the left, and adjacent are the emergency valve chest and resetting lever. The upper half of the wheel casing and bearings are removable, thus permitting removal of the wheels and shaft without disturbing the steam and exhaust piping. The casing is supported



TURBINE WITH CASING REMOVED

on three feet; this does away with the possibility of twisting strains.

The speed of the turbine may be varied while in operation by a simple adjustment of the governor valve. The governor weights are inclosed in a casing, and a protecting hood is placed over the governor as a whole.

When conditions of operation render it desirable, an emergency governor is supplied. This operates independently of the main governor and serves as an added protection. It does not come into play unless the speed rises to about 15 per cent above normal, when it shuts off the steam supply.

From the steam chest the steam is passed through the first-stage nozzles, which direct the flow of steam into the buckets on the wheel. For certain purposes some of the nozzles are opened or closed as required, by hand valves placed in the steam chest. Steam to all nozzles is under control of the main and emergency governors.

Preignitions in the modern two-cycle semi-Diesel engines cannot occur if the atomizer nozzle does not leak. The injection point is fairly late, and no oil is in the cylinder to ignite until practically dead center. If the atomizer leaks, oil will enter the cylinder early in the compression stroke and preignite. If the engine fails to burn all the fuel, at times part remains in the bulb to ignite on the next compression stroke.

Gray System of Automatic Combustion Control

Under date of June 3, 1919, was published a description of a combustion-control system that is now manufactured with improvements, by the Automatic Fuel Saving Co., of Philadelphia and Chicago. By this device the over-fire draft or vacuum is maintained continuously at the most efficient point by varying the air pressure under the grate. The damper is moved to pass a greater or less quantity of air, and the stoker, if there be one, is speeded to meet the demand for fuel.

All these factors are co-ordinated so that simultaneous adjustment is made of coal, air and damper position.

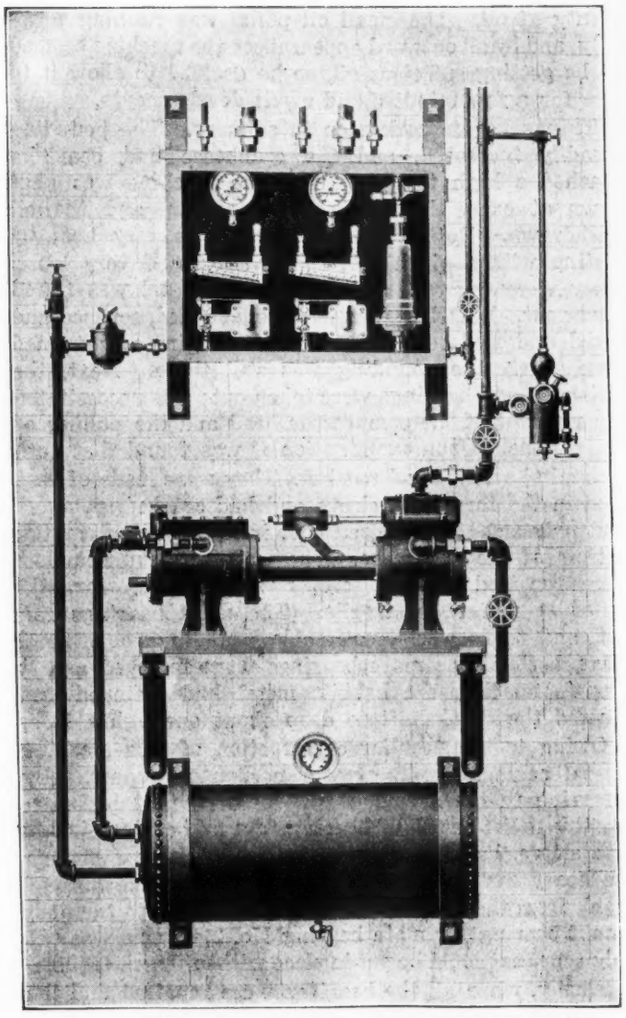


FIG. 1. CONTROL CABINET, AIR COMPRESSOR AND REGULATING EQUIPMENT FOR THE GRAY SYSTEM

The outstanding feature is the maintenance of the over-fire vacuum by the variation of the air pressure under the grate. In the regulation of a number of furnaces this method automatically compensates for variation in the fuel-fed thickness and porosity, so that each boiler is individually controlled, according to furnace conditions existing, and for all, uniform rates of combustion are insured.

It is this feature which distinguishes the present method from the system as originally developed. Control of the three elements of regulation—boiler damper, air supply and stoker speed—is obtained by means of diaphragms operated by compressed air, the necessary variation in the diaphragm air pressure being controlled by two valveless leak ports. One port is actuated by the steam pressure in the header and controls the damper position and the stoker speed. This is a part of the steam-pressure controller system. The second

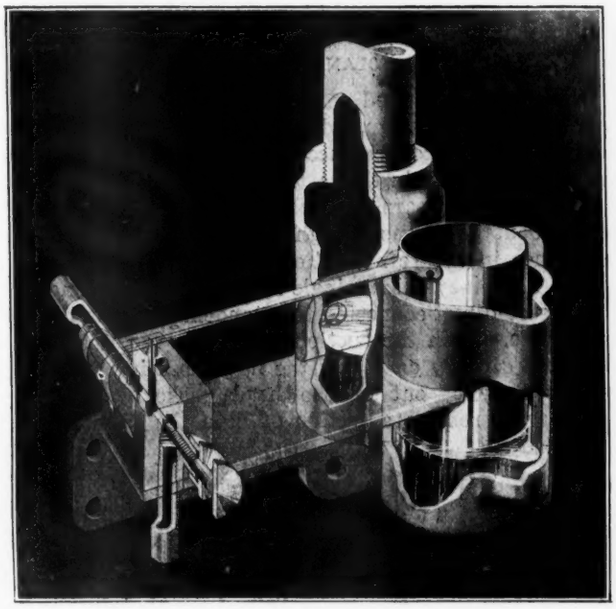


FIG. 3. THE FURNACE AIR CONTROLLER

leak port is actuated by the over-fire vacuum and controls the air supply, being an element of the furnace air controller. Fig. 1 shows a typical control cabinet and apparatus for two boilers, and Fig. 2 illustrates the furnace controller.

The steam-pressure controller is operated by the variations of steam pressure in the header. This pressure is exerted upon a bronze diaphragm and is opposed by a spring whose tension is adjusted for the steam pressure to be carried. If the steam pressure falls, the spring forces down the diaphragm and the steel stem connected to it, thus opening the leak port above and allowing a definite portion of the compressed air passing to the damper and stoker speed diaphragms to escape to the atmosphere. As the pressure on these two diaphragms is lessened, the boiler damper is opened a certain degree and the stoker is speeded up, the variations in either depending on steam-pressure drop.

To illustrate the operation of the control on a battery of boilers, suppose an additional steam-consuming unit is cut into the line. The consequent demand for more steam results in a drop of steam pressure in the header. This pressure drop is transmitted to the steam-pressure controller, which opens the dampers of all boilers in proportion to the drop in pressure. In the case of stoker-fired furnaces the rate of feeding fuel is also increased in proportion. The opening of the damper creates a greater suction in the furnace, and this draft change is communicated through the over-fire vacuum line to the furnace air controller. This regulator, whose function it is to maintain a predetermined over-fire vacuum, speeds up the individual turbo-blower or opens the individual wind-box grate if one blower supplies the air for all furnaces. Thus the under-grate

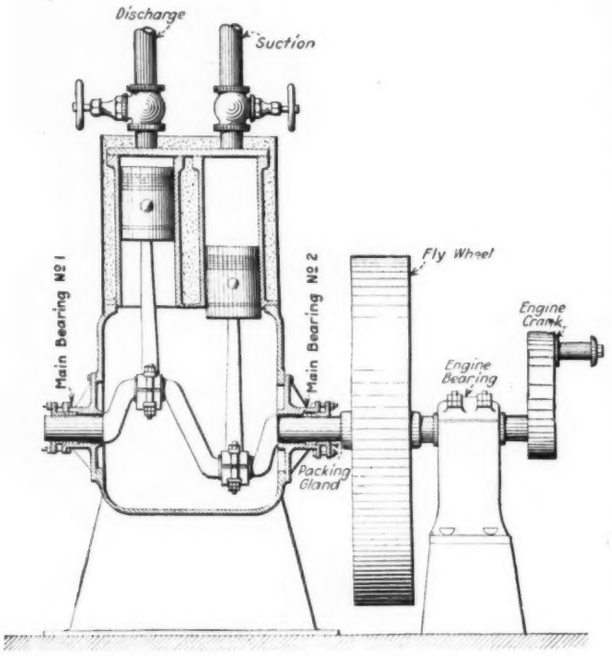
pressure is increased and each furnace is given individual treatment in accordance with its special requirements. The furnace with the highly resistant fuel bed will have a higher under-grade pressure, while the furnace with the less resistant or thinner fuel bed will have a lower under-grate pressure. The over-fire vacuum remains constant, and efficient combustion takes place under varying conditions of furnace and boiler load.

Repairing an Ammonia Compressor

By Roland L. Tullis

Occasionally, we find a piece of machinery of very poor or antique design, which proves a source of annoyance and inconvenience to the engineer. The machine described in this article has been in daily use for a number of years. It was built by a small foundry and undoubtedly was designed by men of no great experience in the refrigeration line.

It is a twin-cylinder, single-acting vertical ammonia compressor direct-connected to a tandem-compound Corliss engine. Both the suction and discharge line were connected directly on top of the head, and in case of a leak or blowing out of the head gasket it became necessary to remove a section of both the suction and



AMMONIA COMPRESSOR WITH IMPROPER MAIN BEARING

discharge line as well as the suction and discharge valve on the line.

In order to remove the head on this machine, the engineer had to remove the bolts and disconnect four flanged joints and take out the suction and discharge valves. It was also necessary to disconnect both bypass valves used in pumping from the high side to low or vice versa. It was an all-day job for two men to remove the head, fit a gasket and replace it, while if the machine had been designed properly, it would not have required more than an hour at the most. The machine was fitted with a solid-flat head. The clearance was very small, and the pulling over of a small slug of liquid in the suction line would either cause the head to leak or blow out the gasket. A blown gasket was a frequent occurrence and necessitated a shutdown and a hard day's labor for two men.

The crank bearings were oiled by the splash system—that is, they dipped into the oil in the crankcase on every revolution—while the main bearing and the wristpin bearings were supplied with oil by a small rotary belt-driven pump connected to the crankshaft. This small pump took oil from the crankcase and forced it through the main and wristpin bearings, whence it was returned to the crankcase.

One day this machine began to moan and groan and pound violently. The shift engineer was a new man and a bit undecided as to what to do in an emergency. The weather was very hot, and the compressor was badly needed to hold down the temperature. He examined the oil gage on the crankcase and made sure that there was plenty of oil. The small oil pump was running properly, and by all outward appearances the machine seemed to be getting sufficient oil, so he decided to allow it to run for a few minutes and await developments.

Things began to develop in a hurry. The pounding steadily increased, and the crankcase and bearings reached a high temperature. The machine was shut down at once, the crankcase opened up and the oil withdrawn. Both crank bearings were very hot; by testing with a pinch bar, they were found very loose. They were removed and the babbitt metal was found burnt out. Both bearings were rebabbitted, scraped and fitted and replaced; but when the engine was turned over slowly the pounding was still there. Next, the wristpins and bearings were taken out; this necessitated the removal of the compressor head and the pulling of the pistons. Upon examination it was found that both wristpin bearings had run hot. They were made of cast iron in the form of a sleeve and had cracked, pounded and pulverized; pulverized cast iron was found in the bottom of the crankcase. The wristpins and bearings were repaired and replaced, but the compressor still failed to run satisfactorily. The main bearings ran hot, and there was a noticeable pounding somewhere. Next, both of the main bearings were removed and it was found that the babbitt metal had softened and allowed the crankshaft to drop about one-eighth inch.

Owing to the peculiar construction of this machine main bearing No. 2 was a corker to repair. By referring to the sketch, it will be seen that it is impossible to lift out No. 2 bearing (a solid bearing similar to a sleeve, babbitted on the inside) without removing the heavy flywheel, engine bearing and engine disk or crank from the shaft. It was finally decided to turn out a split bearing for main bearing No. 2, as this was the only type that could be put in place without much trouble.

Finally, when all the bearings were repaired and the machine properly aligned, it ran as smoothly as a clock. The whole trouble was caused by the complete stoppage of two small oil-feed pipes that delivered oil from the pump to the bearings. The wristpin bearings undoubtedly gave way first, and pulverized cast iron from these bearings probably worked into the other bearings with the oil and completed the havoc. If the machine had been shut down at the first signs of trouble, much work and expense could have been avoided.

The two small oil lines that had stopped up were in an inaccessible position inside of the crankcase. It was impossible to tell whether they were open or not without opening the crankcase. All this tends to show that every machine should be so built that all parts are accessible.

EDITORIALS

Distribution-Cable Maintenance

A FACT too frequently not appreciated is that where heat is generated it must be dissipated as fast as produced or the temperature will soon become excessive. T. H. Arnold's article in this issue, "Some Distribution-Cable Experiences," very forcefully emphasizes the foregoing.

Where electrical cables are installed in the open they are not likely to be overloaded to the point where the temperature of the copper will destroy the insulation—first, because the heat is rapidly dissipated to the surrounding atmosphere, and second, before dangerous loading is reached the volts drop reaches such proportion as to interfere seriously with the service and make some remedy necessary. However, when cables are installed in conduits or in underground ducts, a far different condition exists. Unless air is forced through underground ducts, and it seldom is, the heat must be dissipated at the point where generated in the cable. How fast this heat will be conducted away is a very complicated question, since after reaching the surface of the cable the heat must pass through the air surrounding, or partly surrounding, the cable to the wall of the duct, then through the concrete to the earth. The nature of the ground, the depth below the surface and the number and location of the ducts all have a marked bearing on the heating of the system.

A cable installed in a single duct may carry a load that would prove disastrous if placed in the center of a duct system having a number of loaded cables. In a section of a duct system near the earth's surface cables may operate at a safe temperature, while in a section six feet or more under ground they may have a temperature that is excessive. Even though the system may operate at a safe temperature when first installed, the installation of a steam main near it may result in excessive temperatures. These facts emphasize the necessity of keeping careful check on such systems, for if this is not done expensive repairs may be required, as clearly indicated by Mr. Arnold's experience.

The heat generated in a cable does not increase directly as the current, but as the square; therefore, with a 40 per cent increase in current the amount of heat to be radiated is approximately double that with the original load. Consequently, a small increase in the current above that at which the cables can safely operate may cause a dangerous condition. Overloading of cables is something that generally comes on gradually. When first installed, they may have ample capacity, but machines are added from time to time, and before it is realized the cable is operating at a dangerous temperature. For this reason it is essential that careful record be kept of the loads; if this is done, serious overloading may be avoided, and it is frequently possible to shift some of the load from cables approaching the dangerous point to those that are only partly loaded thus operating the system at a higher efficiency.

Labor Saving in the Plant

THE country has just passed through a period of labor shortage which has brought labor-saving machinery to the front in a very definite manner. The difficulties of keeping labor on the job have been great, and this has been particularly true in coal handling for the power plant. The independence and vagaries of labor in this department have been such that it has been next to impossible to keep men on the coal pile even though a dollar an hour for common labor in unloading coal has been common.

In a certain plant seven men are wheeling coal from the storage pile to the boiler room, and two men on a watch for three eight-hour shifts are distributing this coal to the stokers, making a total of thirteen men for handling the coal to develop nine-hundred boiler horsepower at a labor cost of $52.20 per day. This practice still obtains in spite of the lessons learned from the war and the high prices, which should force economy. There is an enormous field in the coal-handling departments of our industries for labor-saving machinery.

The average power plant cannot be charged with excessive labor costs for coal handling and still be expected to deliver power for a minimum cost per unit of output, more especially since the means of reducing this charge are at hand. When it is added to the cost of the coal itself, the total figure is almost prohibitive. Owners will jump at the chance to get coal at a reduction in price of one dollar per ton, and yet they will pay out day after day the same amount to get this coal into the furnace through inadequate facilities.

Probably the thing most desired is a simple system for getting the coal from the cars to storage and later from storage to the stoker hopper. These operations can absorb a tremendous amount of labor and expense if not efficiently done.

The Producer-Gas Engine

IT IS to be deplored that more efforts are not being made toward an increased use of producer-gas engines. At one time, between 1904 and 1910, a large number of producer-gas plants were installed, there being approximately one thousand such plants in 1912. The decline in the popularity of the producer unit can be attributed to several factors, the most important of which was the irrational producer designs so often sold. Being constructed to give a constant volume of gas, many of these producers were unsatisfactory with a variable gas demand. The skill of the untrained operator was unable to cope with this problem, which in recent years has been eliminated. The commercial appearance of the oil engine, both Diesel and semi-Diesel, using a low-priced fuel oil, also served to decrease the further advance of the producer-gas engine.

There are a large number of plants now using natural-gas engines, which must change over to some other form of power. Gas producers could be installed at a

comparatively low cost. Of the seven or eight hundred engines using gas from the depleted gas fields, the majority are of sizes well within the range of commercial producers.

A second large field for the gas producer and engine is in the Northwest, where there are large bodies of lignite coal. This coal is not very satisfactory for boiler fuel because of its low heating value and high moisture content. On the other hand, it has given excellent results in producers. A number of gas-engine stations have been using this lignite for several years.

Other low-grade fuels, such as sawdust, peat, coke breeze, etc., are quite suitable for producer use. In localities where the price of fuel oil is high, a revival of the producer is to be expected.

Considering the efforts that the two classes of manufacturers employ, it is surprising that there are over fifty producer-gas installations in central stations, while the total number of Diesel central stations reaches a bare one hundred and seventy-five.

Co-operation Among Engineers' Associations

IN AND about New York there are some twenty organizations of operating steam engineers. They meet weekly, biweekly or monthly in small groups. Some carry out, by spurts, more or less ambitious plans of education and self-improvement.

In these groups are many men to whom the association appeals mainly from the fraternal and society side. They enjoy meeting with their fellows and going through the program according to the ritual. They enjoy initiations, luncheons, the smokers, balls and picnics. They are honored by election to the offices and perhaps are sent as delegates to the state and national conventions. They may take a more or less active part in the educational work and technical discussions, but their main interest is in their own little group.

And yet from the point of view of impressing the importance of the power-plant engineer upon the public and the profession, of showing that in responsibilities and attainments and in personality he is vastly different from the popular conception, even from the conception which prevails in certain professional engineering circles, in presenting a representative and united front in matters of legislation and from the point of view of individual advancement in engineering, greater progress could be made with one large organization, meeting amid professional surroundings and in an atmosphere of engineering inspiration.

In the heart of Manhattan is a great building devoted to engineering. It houses the four great professional engineering societies and many others. It has halls and meeting rooms to accommodate any assemblage from a committee meeting to an audience of eight hundred, with the most magnificent engineering library in America, stereopticons, projectors and all the paraphernalia for engineering assemblages. Lecturers are available in any number who would be glad to talk to a sizeable audience in such surroundings, but who cannot be asked to go to some lodgeroom in an outlying district to talk to a group of fifteen or twenty. The United Engineering Societies Building is easily accessible to the members of all the twenty-odd associations referred to.

Without in any way interfering with the autonomy of the existing associations, would it not be possible and worth while to combine those members who would be interested in such a movement into an organization for the holding of meetings for the hearing of papers and lectures upon power-plant engineering and for their discussion? This might be undertaken by the local representatives of one of the national associations, as the N. A. S. E., confining membership in the new organization to members of that association, in which case it would bear the same relation to the individual associations as the Shrine in Masonry bears to the Blue Lodge. Or it might, better, be inclusive of all engineers progressive and ambitious enough to wish to join it. Or again, it might be effected by a large number of such engineers joining the Power Section of the American Society of Mechanical Engineers. Membership in the professional sections is open to those who are not members of the main society, and at a reduced fee. While the professional sections are national in scope, it would be possible, with a sufficiently large local membership, to hold frequent Power meetings at headquarters, and the members of the Power Section would also enjoy the privileges of the sessions of the whole section at the annual meeting. The suggestion in either form is pertinent to other large centers than New York.

Regulation of the Load

WE ARE accustomed to think of the term "regulation" as referring to the speed of an engine. When driving a generator, the speed is of the utmost importance. It has a bearing on the output of the shop and on the over-all economy of the installation. While important in the engine room, proper regulation may effect greater economies in the boiler room, for it is here that the large savings are possible.

Regulation of the feed is a strong factor in the process of making steam. There are too many plants neglecting this factor. In one plant it is the regular custom to blow down ten drums of water per day, letting the feed pump run along at a set speed and "regulating" the feed-water level with the blowoff valve. The wastefulness of this practice may readily be imagined.

But regulation in the boiler room implies more than controlling the feed water. It is often possible to regulate the load on a boiler plant. Any department may take a great deal of steam at one time, while others make a demand at other periods. If properly regulated, the load usually may be made constant and economical, whereas if no attention is paid to it the demand may come from all departments at once. A peak load is created, ashpits get on fire, and an uneconomical condition is produced. After the peak is over, the boilers may loaf along for the rest of the day.

Even on Sunday loads there is an opportunity for regulation. A certain plant recently reduced its Sunday requirement from forty to five tons of coal by regulating the load and doing on a weekday some of the little things that formerly had been done on Sunday.

Too often the engineer's duty is limited to making steam. His business is to keep steam on the line day in and day out. If steam is off at any time, there is immediate trouble. The result is that excess capacity in boilers is kept on the line to meet demands that may or may not materialize. If these demands were regulated, the engineer would know when he could take his boilers out and when to be ready to meet an increase in load. Systematic grouping and regulation of the power and line steam demands in industrial establishments has great possibilities.

CORRESPONDENCE

Packing Expansion Joints

Expansion joints probably give the average institution engineer more trouble than any other one thing; at least this was true in my case until I hit upon a method of packing them that has proved so satisfactory that I am passing it along.

I first fill the stuffing box (with the exception of the last ring) with a good quality of flexible metallic packing, coating each ring with a liberal supply of powdered graphite and cylinder oil. Then I put in one ring of diagonal or cross-expansion packing cut so that the ends meet, thus leaving no room for expansion as is generally called for in directions for applying most packings. The gland is then tightened up until fairly snug. Once a week, choosing a time when steam is off the lines, all the joints are gone over and the brass sleeves are doped with a mixture of cylinder oil and powdered graphite.

As soon as a leak develops the gland is tightened a little. If this does not stop the leak, the ring of cross-expansion packing is removed, the sleeve is polished with a very fine grade of emery cloth, a new ring is fitted, and the job is done in about one-fifth the time it would require to repack the entire box, not to mention the saving in packing. Of a number of joints that were packed in this manner more than two years ago, none have required more than four renewals of the top ring.

A shredded metallic packing was first tried, but it was found next to impossible to apply evenly because of the close quarters in which these joints are installed. The unevenness, of course, caused tight and loose places in the packing when the gland was tightened and resulted in leaks. So a coil metallic packing of the proper size was resorted to with the aforementioned results.

Another point that I have found very important in keeping expansion joints in good condition is that of boiler priming, which always carries more or less scale-forming matter into the steam lines. This scale will invariably find its way into the expansion joints and collect on the sleeves, where it naturally cuts the packing; consequently it is necessary to keep the steam as pure as possible and to remove any scale found on the sleeves.

A. C. McHUGH.

Norwalk, Cal.

Keeping Stuffing-Box Packing Data

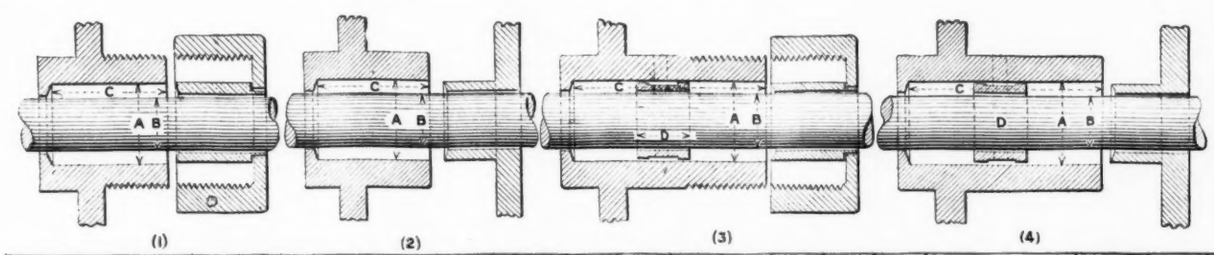
The accompanying record sheet provides an accessible and systematic method for the collection of desirable data on stuffing boxes and their numerous packing conditions, which enables the chief engineer to group all the conditions in order that he may determine the packing most suited for each. This matter, once collected, gives each shift engineer the proper information, so that when he is called upon to pack a particular rod or shaft he may select the proper packing as approved by the operating department.

This information assists in the standardization of packings for certain services and results in fewer style numbers, a smaller stock, better economy in the use of packing and larger purchases in standard styles and sizes, resulting in larger discounts. The sheet should be 24 in. wide by 32 in. long, which allows inserting information on one hundred stuffing boxes, or it may be made longer to suit the requirements of any particular plant.

The stuffing boxes of each unit should be grouped under the description of each unit by stating the name of the unit, size, etc., to distinguish it. Then in the column under the subject, location of stuffing box, enter the location or name, and along the line to the right insert the information as called for in the columns that can be used.

JESSE L. BEST.

Hillsboro, Ill.



Description of Unit	Location of Stuffing Box	Number of Boxes	Dimensions A	B	C	Flat or Taper Bottom	Length of L. Gland-D	Kind of Rod	Kind of Service	Temperature	Length of Stroke	Speed in R.P.M.	Speed in ft. per Min	Type of Box 1-2-3-4	Packing Recomended	Remarks, etc.

METHOD OF KEEPING RECORD OF STUFFING-BOX PACKING DATA

Eliminating Diesel Piston Fractures

In the operation of a horizontal Diesel oil engine it was found that the piston head or firing head burned out about every six months. The fracture usually occurred when the engine load was heavy, making it rather inconvenient to stop the engine. At times the fracture would open up enough to allow the flame to shoot back into the engine frame. The head was removable, being held in place by setscrews. For a time cast-iron heads made at a local machine shop were used, but these held up no longer than the factory ones.

It was noticed that the fracture always started about three inches from the center of the head at practically the same spot. Apparently, there were two causes of the fracture. The design of the head included circular ribs at the front side. In cooling, after casting, these ribs developed stresses in the head. For several reasons ribless heads were deemed inadvisable and effort was directed toward effecting some arrangement whereby the fuel spray would not be centered on this one spot. It was believed that if the spray through the one hole in the spray tip struck this spot, the high temperature, much higher than that of the surrounding metal, would cause expansion and contraction. This finally would result in a small fracture, which, as the gas blew through, would enlarge as the flame burned the edges of the crack.

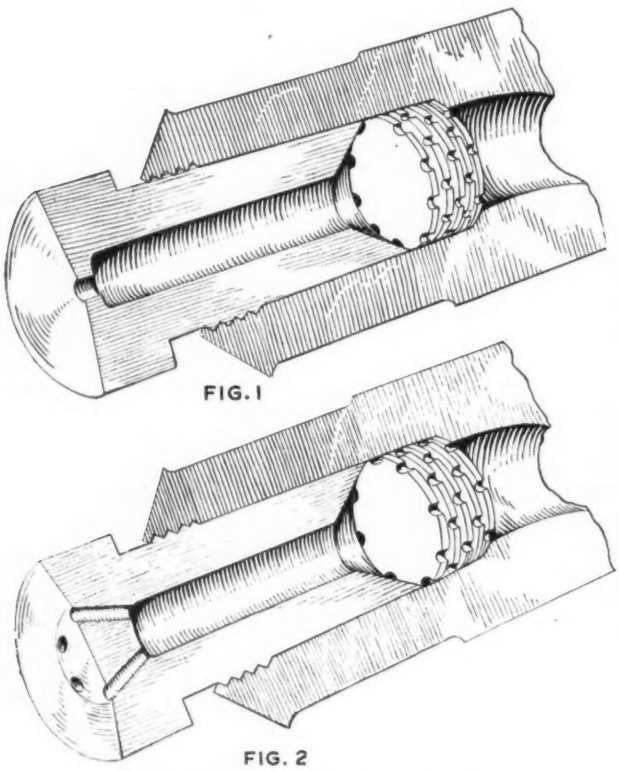


FIG. 1

FIG. 2

ALTERATION OF DIESEL SPRAY TIP

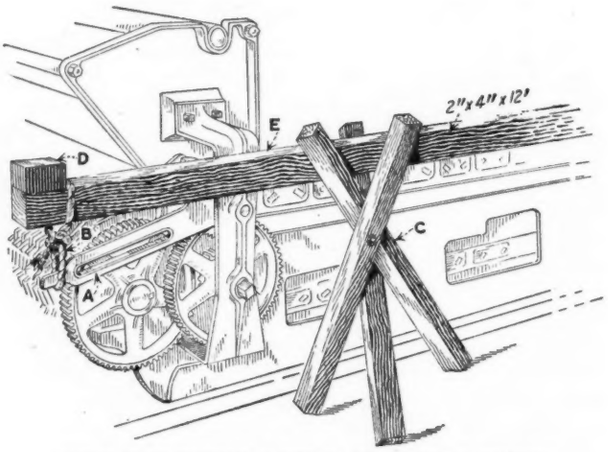
Consequently, the single-orifice spray-valve tip was removed and a tip with six holes substituted. These holes were drilled slightly diagonally with the center line; the oil then issued in six streams, or sprays, and covered a greater portion of the combustion space. This stopped further fracturing of the piston head. A decided improvement was noticed in the color of the exhaust. Originally, it was always slightly dark and the piston head usually was covered with carbon. With the new tip it seems that the oil is broken up better and is mixed with a greater amount of the air, giving better combustion. Figs. 1 and 2 show the fuel-spray valve with the old and new tips.

GEORGE GROW.

Philadelphia, Pa.

Carrying the Load Without Stoker Shafting

The first thing after the noon hour we haul out the coal cars that have been unloaded and also the cinder car. The tracks are parallel, but the cinder tracks are about four feet lower than the coal track. We do the switching with a small electric locomotive. One day, for some reason or other, some new men were on the job and everything went all right on the taking-out part, but the damage was done in replacing the empty coal cars with full ones.



HOW THE STOKERS WERE OPERATED UNDER AN EMERGENCY

They were going to put in one of those high coal cars, when the switchman threw the wrong switch and the car went down the grade into the cinder pit, pulling the little locomotive after it. The car mowed down every foot of stoker shaft, which was in the basement.

There I was with a big load and no stokers. It happened that we had all chain-grate stokers. I hustled some men up to the boiler room and pumped the stokers by hand. Meanwhile the distress whistle was sounded, which brought the linemen, sectionmen and extra motormen to the scene of trouble. Then we began figuring how the stokers could be kept going, as it took two men on each stoker on fifteen minute shifts.

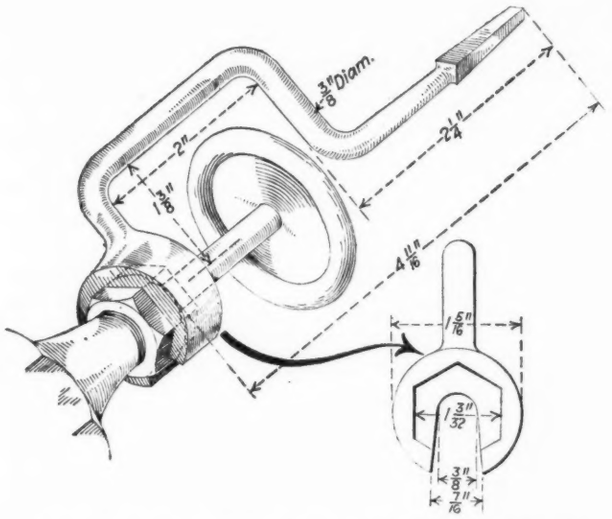
Upon the suggestion of one of the men we made the apparatus shown in the illustration, from 2 x 4-in. timber. *A* is the lever on the stoker, *B* is a rope, *C* is a three-legged sawbuck, *D* is a balancing weight of firebricks, *E* is a 2 x 4-in. by 12-ft. stick for a lever. One man could sit on a box and run a stoker for two hours at a time if necessary. We ran this way for 48 hours and dropped only 200 kw. of the load, and this was at the time of the accident. We stored two of these strong-arm stokers away for fear something might happen to one of our eccentrics or some other part of the stokers. Thanks to the stoker designers for that lever *A*.

E. LITTLEFIELD.

East St. Louis, Ill.

Valve-Stem Packing Wrench

Where there are many small-sized valves to be packed, such as the radiator valves on a heating system, it will pay to provide the men doing the work with a wrench of the type shown for each size of valve used on the system, such as ½-, ¾- and 1-in. sizes. With such simple wrenches with a shank to fit a breast drill or a bit-brace having the usual ratchet, any man can easily, conveniently and generally with comfort repack nearly twice as many valves per hour as he can with the common wrench. The wrenches can be made of a cheap grade of tool steel forged to size, smoothed up a little on an emery wheel, heated and tempered slightly. Such wrenches will often save their cost in the packer's time alone the first day they are used.



PACKING-NUT WRENCH FOR USE WITH BIT-BRACE

The dimensions given are for a certain size of wrench and will vary with the size and make of valve. Even though several makes of valves may be used in one plant, it is possible to make one wrench serve, as it may be a little loose on the packing units without without injury. A set of two or three wrenches generally is sufficient.

Richmond, Va. FREDERICK W. SALMON.

Does a License Law Help?

After reading the article on engineer's licenses by L. M. Reed, page 833 of the Nov. 23 issue of *Power*, I wish to ask Mr. Reed a few questions. I am operating in a state where but a few cities have any semblance of a license law. I hold a city license. If I were to go to Massachusetts where would I be likely to land? Where I am now I must have an engineer's position in order to secure a license, and a license in order to secure a position as an engineer.

In this city a man may operate although his license may have expired nearly a year, and firemen on days with an engineer are not licensed, but night firemen operating alone are.

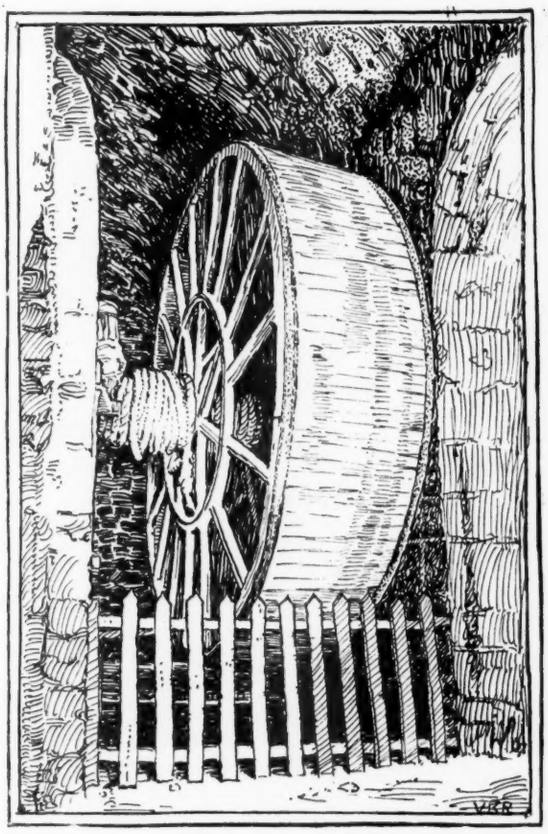
Mr. Reed's statement that there can be no Federal licensing of stationary engineers is erroneous, I believe. How about the marine license? If there is any time that the United States Government cannot pass a law on account of states rights, then all I have to say is it is a queer country.

Speaking of men holding various licenses, I worked for a chief engineer who held a Massachusetts first-class license. He had a four-valve engine the crank rod of which was so designed that the wedge bolts are behind the crankpin on one end and ahead of the crosshead pin on the other. Owing to the continual tightening up a noisy thump made its appearance on starting and stopping, but during running no noise was heard. Indicator diagrams showed that the head end was running with the piston up against the head. Perhaps this instance is an exception to the rule. This same engineer would come into his plant and see three engines where there was but one, and he was a chief engineer. R. G. SUMMERS.

Rochester, N. Y.

An Elevator With an Interesting History

The pen-and-ink drawing shown in the figure is from a postal card brought from France by William La Follette, of Kaycee, Wyo., who served overseas. It is an old treadwheel elevator run by six men, used about the Eleventh to the Thirteenth Century, for lifting provisions up approximately eighty feet to an old monastery that was separated from the main land, on the road between Brittany and Normandy at Mont Saint-Michel.



TREADWHEEL FOR ELEVATOR

What a story it tells of the evolution of the use of power, comparing it with our modern electrically operated elevators equipped with safety devices and gate interlocks invented for the safety of life and property!

Washington, D. C. THOMAS M. ROBERTS.

Instruments for the Boiler Plant

Many articles have been written on the subject of boiler-plant instruments, and it is needless to say that each has contained its percentage of good. Among the thousands of power plants in this country it is safe to say that the majority of them do not have the necessary instruments for checking fuel waste and incident boiler losses.

In the large, well-regulated and efficiently operated station will be found instruments that control the efficient operation of boilers under all load conditions. The largest number of plants where few or no instruments will be found are those ranging from 500 to 5,000 hp. rated capacity. Among the offending classes are such plants as railroad shops and terminal power plants, municipal light and water stations, ice plants and privately controlled manufacturing plants.

Instruments are necessary aids to efficiency. Their proper selection is of next consideration, and then follows the purchase of instruments that will stand up to the hard use of the boiler plant.

As a specific case take a hand-fired plant containing six 400-hp. water-tube boilers. The boilers are clean internally as well as externally, the settings are in good condition, baffle walls tight, furnaces and grates in good order. The load is more or less fluctuating, and the boilers are frequently operated at 125 per cent rating. The fuel burned is of semi-bituminous structure and grade run-of-mine.

In this plant there is a daily consumption of 76 tons. No instruments are used for checking fuel waste, and after checking the situation with test instruments, it was determined that with proper instruments a 10 per cent saving in fuel could be effected. Coal at $5.15 per ton cost $391.40 per day, $11,742 per month, $140,904 per year. The saving possible is $14,090.40 per year.

The instruments recommended consisted of the following: Three combined draft and CO_2 recorders complete with collecting tanks, $1,342; six 2-in-1 draft gages, $330; three two-record continuous recording flue-gas pyrometers, $1,050; miscellaneous and installation, $200; total investment, $2,922.

The plant had previously been equipped with recording steam and air gages, recording feed-water thermometer, recording steam-temperature thermometer, indicating-recording steam-flow meter and indicating venturi water meter.

The personnel of the plant is composed of men who could be trained to operate the boilers efficiently provided the necessary instruments were furnished, and in a short time would no doubt show savings even in excess of the determinations made.

With the necessary data at hand, the plant owners were advised that with proper equipment the plant could be made to save them $14,090.40 per year in fuel alone by reducing the present preventable waste. To the figures shown, however, no consideration was given, due perhaps to the fact that the idea cannot be grasped by them that by simply adding instruments and training firemen to use them a saving of 10 per cent in fuel can be made. However, in this same plant, very close consideration is given to maintaining the generating engines, pumps, compressors, heaters and all steam lines in good condition. This is commendable, and it is due no doubt to the fact that wastes in the use of steam are more or less readily detected, but the invisible loss of several hundred heat units going out the chimney is just the same.

Many plants employ competent engineers, pay them good wages and expect results. The wide-awake engineer is constantly on the lookout to keep his plant in tune, and yet many a competent man fails to make good, owing to the lack of support given him by his employer, who pays the bill. The waste is passed on to the consumer, who is the general public paying the price to waste our material resources and never stopping to inquire why steps are not taken to reduce this to a minimum.

Hand-fired small plants are still in the majority, and to the owners of such plants we should look for more economy of operation, and to get this an adequate check should be kept from day to day. Instead of CO_2 around 6 per cent, get 12 to 14 per cent; instead of flue gases around 600 to 800 deg. F., get from 400 to 500 deg. It is being done and can be done. Co-operation between owner and engineer will work wonders.

Hagerstown, Md. PAUL R. DUFFY.

Gasket Caused Lubricating Trouble

The following, relative to lubricating troubles with our engines caused by stoppage of pipes, etc., due to an inferior grade of oil, may be helpful to others.

The same lubricant worked very well on another engine of the splash-oiling type while the oil was being used for the first time. After being filtered and used the second time, it became too thick to flow through the pipe leading from the crankcase cover to the main bearing. If two gallons of this used oil remained in a pail for twenty-four hours, there would be about two quarts of oil at the top; the rest would be a thick spongy mass.

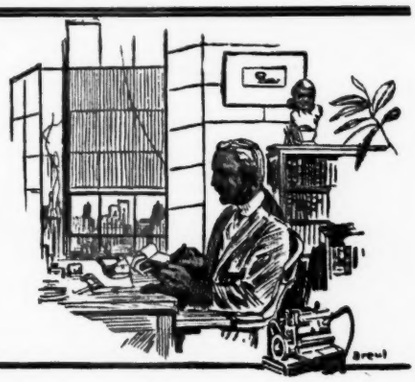
During this time a larger engine of the splash-oiling type was being repaired, and a better grade of oil was obtained so that it would be on hand when this engine was placed in service. When this unit was started up with the new oil, it developed about the same condition, apparently, as with the other oil, only it would thicken up in about twelve hours and before it was filtered. This was surprising, for I knew that the oil was next to the best grade made by the company from which it was purchased. At my request the company sent a representative to our plant, but he could give no reason for the trouble.

When the mechanic who was doing the repair work on this engine was getting ready to start up, he found it necessary to put a new gasket on the cover to the crosshead opening, and as there was nothing else at hand, he used a sheet packing made from some kind of paper and cut it the full size of the cover plate.

The day following the salesman's call this plate was removed for the purpose of inspecting the crosshead and the first thing noticed was that this packing was disintegrating from the action of the oil upon it and small particles which could be rubbed off with the finger resembled the sediment in the oil. This gave me a clue, so the center of the gasket was cut out, leaving just enough to make an oil-tight joint. Then the crankcase and other accessible parts with which the oil came in contact were thoroughly cleaned, fresh oil was put in the crankcase, the engine put in service and our troubles had disappeared. Now we can run the same engine several days without changing the oil.

New York City. A. K. VRADENBURGH.

INQUIRIES OF GENERAL INTEREST



Running Oil Engine with Cracked Piston—If the piston of an oil engine becomes cracked halfway around the skirt below the pin, would it be safe to run the engine in that condition? E. T.

It would not be safe, as the defective piston probably would break and drop when the engine was running. The piston should be replaced by a new one.

Choice of Refrigerating System—Is a brine-spray or a direct-expansion system more desirable for a beef chill-room? R. H.

The brine-spray system is more popular at present. Its cooling capacity is greater and the danger of ammonia leakage is avoided. It has the disadvantage of causing pipe corrosion due to aëration.

Discharging Steam-Heating Returns to Common Receiver—We are having difficulty in the drainage of high- and low-pressure returns to a common receiver for use of the returns as boiler-feed water. Each system of returns is provided with a separate trap, but the low-pressure returns will not discharge. How can the trouble be remedied? Would not placing a check valve in each return prevent the higher pressure returns from backing up into those of lower pressure? F. B.

Check valves may prevent the returns of higher pressure from backing up into those of lower pressure, but it will be impossible to secure drainage of any return to the receiver unless the receiver pressure is maintained below the delivery pressure of that return. The return main of each system should be connected separately to the receiver, and to insure the delivery of all returns and prevent a higher pressure return from backing up on those of lower pressure, the receiver should be provided with a small vapor pipe discharging to the atmosphere, so as to insure no rise of pressure above the pressure of the atmosphere. The relative waste of heat will be very small and it may be reduced to a minimum by providing the vapor pipe with a small safety valve set to relieve the pressure of the receiver a few pounds below the lowest discharge pressure of any of the returns.

Location of Direct Radiators—Are direct radiators more effective for heating a room when placed along outside walls and at windows than when placed anywhere else in a room? J. E. N.

If the atmosphere of a room could be free of air currents excepting those induced from operation of the radiator, then a radiator of given size would be less effective for obtaining a high average room temperature when placed alongside of an outer wall or at a window than if placed almost anywhere else in the room, because when placed alongside of the outer wall the latter is heated to a higher temperature and there is more rapid transmission of heat to the outside of the building. But in most cases it is desirable to maintain a comfortable temperature of rooms near their outside walls and windows, and the chilling effect of walls and windows must be counteracted without overheating other portions of the rooms; it also is desirable to intercept cold air currents coming through the crevices of walls and windows. If the measure of effectiveness is uniformity of satisfactory room temperature rather than the obtainable average of temperature of different parts of the room, then with ordinary building construction and a sufficiency of heating surface, location of radiators along outer walls and windows will cause them to condense rather more steam, but usually will be found more effective for satisfactory distribution of heat.

Vibration of Steam Gage for Lower Boiler Pressure—Why does the pointer hand of the steam gage on my 90-hp. return-tubular boiler quiver when the pressure is below 80 lb. while running a 12 x 12-in. engine 270 r.p.m.? The gage is steady when the pressure is above 85 lb. W. H. P.

The pointer quivers because of sudden reduction of the boiler pressure at each stroke of the engine while taking steam. For the same load the engine takes from the boiler a larger volume of steam per stroke when the pressure is lower, and consequently there is greater lowering of the pressure and greater vibration of the gage pointer. The quivering can be dampered by slightly throttling the stop cock of the gage, and the flow of steam from the boiler can be made steadier, with less fluctuation of the boiler pressure by providing a receiver in the line between the boiler and engine.

Content of Horizontal Cylindrical Tank—How many gallons of a liquid would be contained by a cylindrical tank 7 ft. in diameter and 26 ft. long, laid horizontally, when filled with the liquid to a depth of 32 in.; and also to a depth of 65 in.? V. C. R.

For a tank 26 ft. long with flat ends, each square inch of cross-sectional area would represent a capacity of $(26 \times 12) \div 231 = 1.351$ gal.

When the liquid is of less depth than one-half the diameter of the tank, the form of cross-section of the contained liquid would be a segment of a circle, the area of which is given by the formula,

$$\text{Segmental area in sq.inches} = \frac{4H^2}{3}\sqrt{\frac{2R}{H} - 0.608}$$

where H is the height of segment in inches and
R is radius of tank in inches.

Calling $H = 32$ and $R = (7 \times 12) \div 2 = 42$, by substitution the formula becomes

$$\text{Segmental area in sq.inches} = \frac{4(32)^2}{3}\sqrt{\frac{2 \times 42}{32} - 0.608}$$

$= 1{,}938.8$ sq. in.
and for 32 in. depth the liquid content would be $1{,}938.8 \times 1.351 = 2{,}619.3$ gal.

When the tank is completely filled, the cross-sectional area of the contained liquid would be $84 \times 84 \times 0.7854 = 5{,}541.8$ sq.in. When filled to a depth of 65 in., the cross-section of the unfilled space above the surface of the liquid would be a circular segment $84 - 65 = 19$ in. high, having an area of

$$\frac{4 \times (19)^2}{3}\sqrt{\frac{2 \times 42}{19} - 0.608}$$

$= 939.5$ sq.in.; hence the cross-sectional area of the liquid filled to a depth of 65 in. would be $5{,}541.8 - 939.5 = 4{,}602.3$ sq.in., and when filled to that depth the tank would contain $4{,}602.3 \times 1.351 = 6{,}217.7$ gal.

Effect of Fittings on Flow of Liquid Through Pipe Lines*

By DEAN E. FOSTER

IN THE layout of piping in power plants and heating systems the engineer is frequently confronted with the problem of the proper allowance to make for the effect of the fittings on the flow of gases and liquid. In the writer's work he has used the charts and tables given in "The Mechanics of Heating and Ventilation," by Konrad Meier. They are, however, objectionable on account of the time required in using them. It is not a difficult matter to formulate the relation existing between the resistance of fittings and the resistance of piping. For the flow of water Mr. Meier gives

$$H_f = \frac{0.0257}{2g} \times V^{1.86} \times \frac{L}{d^{1.25}}$$

the resistance offered to flow by fittings

$$H_r = 1.38r \times \frac{V^{1.86}}{2g}$$

where H is loss of pressure in feet; L is length in feet; H_r is loss of pressure per fitting; r is a factor depending on the shape of the fitting; d is the pipe diameter in inches; V is the velocity in feet per second. Combining these two equations, the following is obtained: $Le = 53.75 \times rd^{1.25}$, where Le is the number of feet of pipe equivalent in resistance to a fitting.

Table I is based on this equation and may be used for oils of 32 Baumé or higher and for water.

For the flow of high-pressure steam through pipes Mr. Meier gives the equation,

$$P_f = \frac{W}{144} \times 0.0257 \times \frac{V^{1.95}}{2g} \times \frac{L}{d^{1.2}}$$

Where P_f is the pressure in pounds per square inch re-required to overcome fractional resistance. For the resistance of fitting he gives

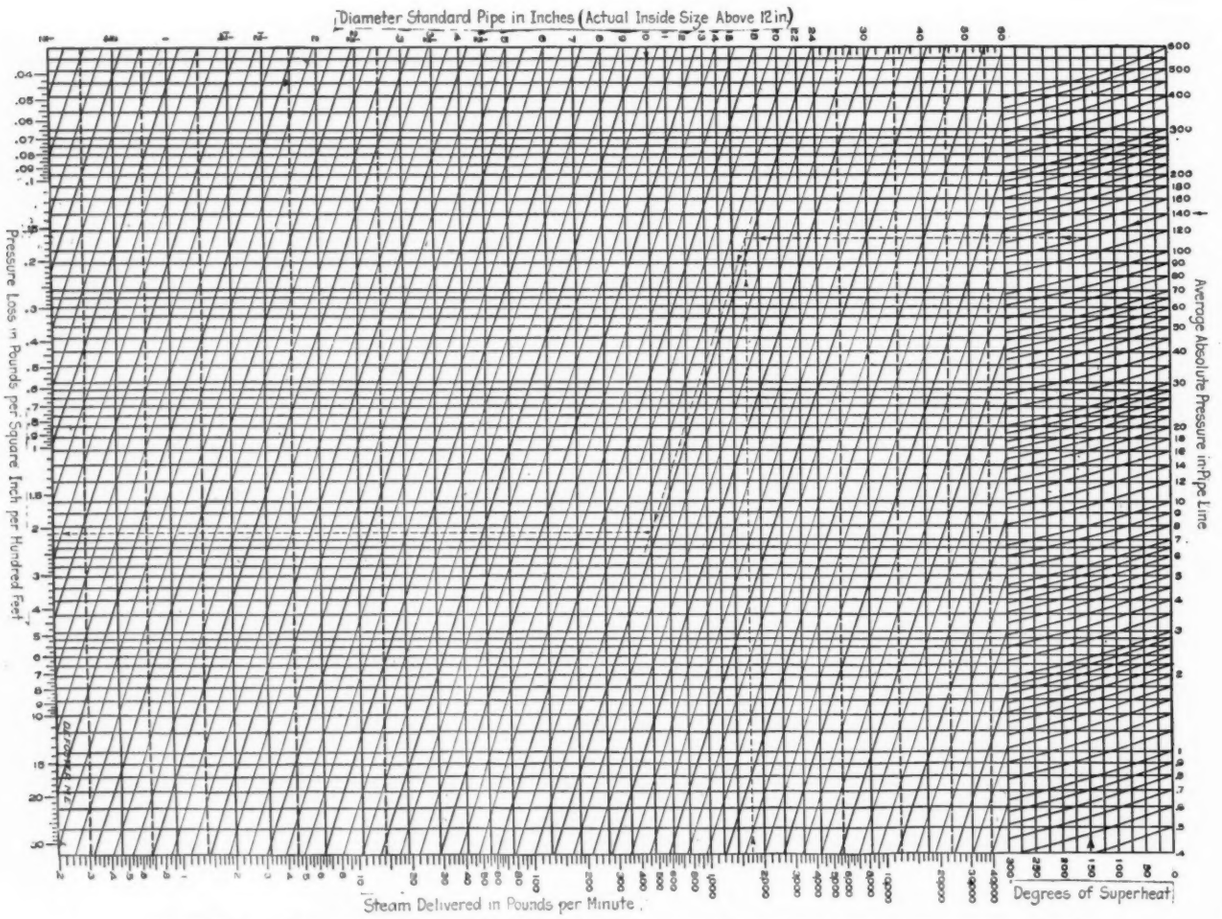
$$P_r = \frac{W}{144} \times 1.12r \times \frac{V^{1.95}}{2g}$$

combining the two equations

$$L_e = 43.7\, rd^{1.2}$$

The author assumes that the loss of gas or air and steam losses through fitting do not differ to any extent and feels that the equivalents in Table II apply to all three.

Many charts and diagrams for the quick determination of steam pipe sizes have been published, but they have all been constructed under the assumption that dry saturated steam was the fluid to be carried. The accompanying chart, however, solves problems involving the carrying of either dry saturated or superheated steam. In order that its use may be clear the following case has been assumed, the


Diameter Standard Pipe in Inches (Actual Inside Size Above 12 in)
Pressure Loss in Pounds per Square Inch per Hundred Feet
Average Absolute Pressure in Pipe Line
Steam Delivered in Pounds per Minute
Degrees of Superheat

GRAPHICAL SOLUTION OF BABCOCK'S FORMULA FOR FLOW OF STEAM THROUGH PIPE

*Extract of paper read before the American Society of Mechanical Engineers at annual meeting, Dec. 7-10, 1920.

pressure loss in pounds per square inch per 100 ft. being desired:

Average steam pressure in line	140 lb. abs.
Superheat	150 deg.
Amount of steam to be delivered	1,700 lb. per min.
Size of pipe	10 in. standard

TABLE I. EQUIVALENT LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING NON-VISCOUS LIQUIDS

Formula Used: $L_e = 53.75rd^{1.25}$

Nominal Pipe Size, In.	Actual Inside Diameter, In.	Gate Valve	Long-Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size ½	Standard Elbow or on Run of Tee Reduced in Size ½	Angle Valve	Close Return Bend	Tee Through Side Outlet	Globe Valve
Factor of Resistance.....		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
¼	0.662	0.335	0.442	0.56	0.89	1.20	1.34	1.79	2.68
⅜	0.824	0.475	0.627	0.79	1.27	1.71	1.90	2.52	3.80
1	1.049	0.640	0.844	1.07	1.72	2.30	2.56	3.40	5.12
1¼	1.38	0.902	1.19	1.51	2.42	3.24	3.61	4.80	7.22
1½	1.61	1.09	1.43	1.83	2.92	3.92	4.36	5.79	8.72
2	2.06	1.49	1.96	2.50	3.99	5.36	5.96	7.92	11.92
2½	2.46	1.86	2.46	3.13	5.00	6.72	7.47	9.93	14.94
3	3.06	2.46	3.25	4.11	6.66	8.87	9.86	13.11	19.72
3½	3.54	2.92	3.80	4.91	7.84	10.53	11.70	15.56	23.40
4	4.026	3.44	4.53	5.77	9.22	12.37	13.70	18.28	27.50
4½	4.506	3.95	5.20	6.63	10.60	14.22	15.80	21.01	31.60
5	5.047	4.57	6.00	7.68	12.20	16.47	18.30	24.33	36.60
6	6.065	5.72	7.55	9.61	15.30	20.61	22.90	30.45	45.80
7	7.024	6.90	9.10	11.59	18.50	24.84	27.60	36.70	55.20
8	7.981	8.10	10.69	13.60	21.70	29.16	32.40	43.09	64.80
10	10.020	10.70	14.10	17.97	28.70	38.52	42.80	56.92	85.60
12	12.090	12.50	17.80	22.68	36.20	48.60	54.00	71.82	108.00

TABLE II. LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING STEAM, AIR, OR GAS

Formula Used: $L_e = 43.7rd^{1.2}$

Nominal Pipe Size, In.	Actual Inside Diameter, In.	Gate Valves	Long Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size ½	Standard Elbow or on Run of Tee Reduced in Size ½	Angle Valve	Close Return Bend	Tee Through Side Outlet	Globe Valve
Factor of Resistance.....		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
¼	0.622	0.031	0.41	0.52	0.84	1.12	1.25	1.66	2.50
⅜	0.824	0.044	0.57	0.73	1.17	1.57	1.75	2.33	3.50
1	1.049	0.057	0.77	0.98	1.57	2.11	2.34	3.11	4.68
1¼	1.380	0.082	1.07	1.37	2.19	2.94	3.27	4.35	6.54
1½	1.610	0.098	1.29	1.64	2.63	3.52	3.92	5.21	7.84
2	2.067	1.32	1.74	2.23	3.55	4.77	5.30	7.05	10.60
2½	2.469	1.64	2.16	2.75	4.39	5.91	6.56	8.71	13.12
3	3.068	2.13	2.81	3.59	5.72	7.69	8.54	11.40	17.08
3½	3.548	2.53	3.34	4.26	6.80	9.10	10.13	13.50	20.26
4	4.026	2.96	3.90	4.97	7.94	10.65	11.84	15.75	23.68
4½	4.506	3.27	4.45	5.66	9.05	12.14	13.50	17.95	27.00
5	5.047	3.88	5.11	6.42	10.40	13.95	15.51	20.60	31.02
6	6.068	4.81	6.35	8.09	12.90	17.35	19.27	25.60	38.54
7	7.023	5.75	7.59	9.66	15.40	20.70	23.02	30.60	46.08
8	7.981	6.70	8.85	11.20	17.90	24.10	26.80	35.60	53.60
10	10.02	8.75	11.54	14.70	23.40	31.50	35.00	46.60	70.00
12	12.09	10.90	14.40	18.35	29.30	39.30	43.70	58.10	87.40

In the solution shown the chart is entered on the horizontal line representing 150 deg. of superheat. This line is followed to the left until it intersects the curve representing 140 lb. pressure. From this intersection the dashed vertical line is followed down to its intersection with the horizontal dashed line representing 1,700 lb. of steam. From this intersection the inclined dashed line is followed to its intersection with the horizontal line representing 10-in. pipe. The vertical thus determined gives the loss required as 2.08 lb. per 100 ft. Had a 12-in. pipe line been used, the loss would have been only 0.81 lb.

The chart can be used for the solution of any case where four of the variables are known and the fifth is to be determined. For the solution of problems involving dry saturated steam, enter the chart at the top at the point representing the pressure assumed and follow a vertical line from this point to its intersection with a horizontal representing the desired quantity of steam. The remainder of the solution will be the same as outlined for superheated steam. If the part representing superheated steam were omitted, this chart would be very similar to one constructed by H. V. Carpenter, Mem. Am. Soc. M. E., and published a number of years ago in *Power*.

Discussion by Professor Giesecke

Professor Giesecke, of the University of Texas, challenged the fundamental principle of the paper, the substitution of an equivalent length of straight pipe for a fitting, on the score that the loss in the fitting follows an entirely different law, with respect to velocity, from that in the straight pipe. He quoted, as authority, tests made by him at the University of Texas in 1912-13 and 1916-17, recorded in bulletin No. 1790 of the University. Mr. Foster admitted this point, but claimed that his relations were approximately true for the range of velocities commonly used in practice. He then made two interesting additions to the discussion. The first of these was that the larger the pipe diameter the more noticeable the losses in fittings compared to those in the straight pipe. This, he explained, was because the loss in the fittings is due to eddies, which are the result of pressure difference between the inside and the outside of the bends; and that this pressure difference becomes greater and the paths of the eddies of greater cross-section, as the diameter of the fitting increases. His second point was that increasing the radius of curvature of a long-sweep bend does not necessarily decrease the loss in that bend, as this loss is a function both of the rate of change of direction of flow and of the duration of this change of direction; that the first factor decreases as the radius of the bend is increased, but the second one increases with the length of the bend and therefore with its radius. There is a certain radius for which the loss in the bend is minimum.

Public Utility Development in California

Expressing its belief that never again will California face as serious a power situation as that created in 1919-20 by the rare combination of the excessive demand for electric power with a minimum supply, the latter condition being due to three years of scanty rainfall, the Railroad Commission of California, in its report to Governor W. D. Stephens, tells of utility development work now going on in the state. Referring to the fact that utilities early in 1919 began to carry out hydro-electric construction plans interrupted by the war, the commission lists projects under way which, completed, will add 275,000 kw. to the state's output of electric power. Of this power 250,000 kw. is hydro-generated and 25,000 steam-generated.

According to the report of the commission, the San Joaquin Light and Power Corporation, Southern California Edison Co., Great Western Power Co. and the Southern Sierras Power Co., also the City of Los Angeles, in July, 1920, were actively engaged in increasing plant capacities to meet demands for electric energy.

The San Joaquin Light and Power Corporation recently completed its Kerckhoff[1] plant on the San Joaquin River, a plant designed to have a capacity of 30,000 kw. This corporation also completed a 12,500-kw. addition to its steam plant at Bakersfield[2], the plant using natural gas from the Midway gas fields as fuel. In addition to these developments it is completing at 100,000-volt transmission line from its Kerckhoff development to McKittrick and has plans under way for the installation of a 12,500-kw. steam plant near the gas fields, to be completed before summer.

The Southern California Edison Co. has also been active in the development of power. It has been engaged in the completion of its Kern No. 3 power plant, of 30,000 kw., on the upper Kern River, which should be completed early in 1921. This plant has no storage facilities and depends

[1]See *Power*, Dec. 14, 1920. [2]See *Power*, Dec. 7, 1920.

entirely upon stream flow; it should have an average output of at least 150,000,000 kw.-hr. annually.

The Edison Co. should complete late in 1920 an additional unit of 17,500 kw. to its Big Creek No. 2 plant. It has under construction, for completion in 1921, a diverting dam and tunnel from Shaver Lake reservoir to its Big Creek No. 2 plant, which should be completed in the fall of 1921, and is carrying on the construction of a third plant on Big Creek of 25,000 kw. capacity, known as Big Creek No. 8. Other plans of the company contemplate commencement of work to bring to the Huntington Lake reservoirs waters from the south fork of the San Joaquin River, through a tunnel approximately ten miles in length and requiring several years to complete.

The Great Western Power Co. is actively engaged in construction work on its Caribou development. The first unit of the plant, totaling 40,000 kw. capacity, is expected to be in operation early in 1921. The development consists of tunnels diverting the waters from Lake Almanor to Butt Creek, and additional tunnels from Butt Creek along the mountainside to a point where the water will be dropped through penstocks to the Feather River below, a difference in elevation of 1,140 ft. The first is being so constructed that two more units, bringing the total to 80,000 kw., may be added before increased capacity will be required.

The Southern Sierras Power Co. has also been active in the construction of its Levining Creek plant of 10,000 kw., which will not be completed until the fall of 1921. It also has under construction its Adams plant, in the Owens River gorge, of 2,500 kw., to be in operation in the spring of 1921. During the past this company has reinsulated its entire transmission line so as to transmit energy at 85,000 volts, and is now operating the line at that voltage.

The City of Los Angeles has recently completed its San Francisquito No. 2 plant on the aqueduct near Saugus, with a capacity of 20,000 kw. It also is contemplating the completion of its San Fernando and Franklin Canyon plants, which will further enlarge its capacity.

The Los Angeles Gas and Electric Corporation is adding a 10,000-kw. steam unit to its equipment.

The Pacific Gas and Electric Co., serving most of northern California, did not begin construction of any hydro-electric plant until 1920, when work was started on a 12,500-kw. unit to be added to its Oakland steam plant and to be in operation by the winter of 1920. It has also started construction work upon two 10,000-kw. hydro-electric plants on Hat Creek, a tributary of Pitt River, and has plans under way for the construction of a 60,000-kw. plant on the Fall River. It has also commenced work upon a 220,000-volt transmission line to transmit the power thus produced from the Pitt River, some 250 miles or more, to the San Francisco Bay district. This new line will be the highest-voltage transmission line so far to be constructed in the United States. A small plant of approximately 9,000 kw. on the Stanislaus River, to be known as Spring Gap, is expected to be installed by the summer of 1921.

Motor-Fuel Symposium

Four prominent speakers and an extended discussion aroused a great deal of interest at the 312th meeting of the Chemical Society of Washington, Thursday, Dec. 9, when the entire program was devoted to a symposium upon the present status and future prospects of motor-fuel supply.

R. W. Ambrose, Chief Petroleum Technologist of the Bureau of Mines, discussed petroleum products for motor-fuel supply. He described the three classes of investigators of this subject as pessimists, optimists and super-optimists. The pessimist believes the problems cannot be solved; the super-optimist believes there is no problem. Neither of these classes is right in Mr. Ambrose's opinion. The optimist believes that there is a problem of difficulty, but that it can be solved by proper planning.

The present gasoline requirements of the country indicate a need for from 4 to 4.5 billion gallons of motor fuel for 1921. This represents many times the demand of ten years ago, but the crude oil available from domestic production is only about twice that of ten years ago. The output of motor fuel has been increased from petroleum by better recovery of crude, by higher-percentage recovery of motor fuel during refining and by conservation in use of fuel, Efficiency on the part of the ultimate consumer is the most promising means of relief of the shortage.

Shale-oil development, still in its infancy as a commercial business, offers little encouragement for the present, because of the difficulty of economical retorting to secure an easily refinable product for motor-fuel production.

Coal-Tar Products as Motor Fuel

W. M. Rile, of the Barrett Co., discussed the subject of coal-tar products as a source of motor fuel, especially motor benzol. This is really a mixture of benzol, toluol and xylol. Typical specifications for motor benzol are: 0.878 specific gravity, neutral reaction, sulphur not exceeding ¼ per cent, ability to pass the "doctor" test and the gumming test, and distillation as follows: First drop 79 to 80 deg. C., 60 per cent below 100 deg. C., 90 per cent below 121 deg. C., dry at 135 deg. C., with no appreciable residue. Because of the greater vapor tension at a given temperature and materially higher heating value of benzol per gallon as compared with gasoline, distinct advantages in the way of thermal efficiency and miles per gallon are experienced. However, under present conditions the total available motor benzol supply of the country, even if all light oil from byproduct coking and city gas plants equipped for light-oil recovery be included, is barely 2½ per cent of the gasoline requirements of the country. By extreme measures, including byproduct recovery from all coal coked, stripping of all city gas supplies for light oil and other increases to be expected during the next few years in these lines, we cannot anticipate that much over 5 to 10 per cent of the gasoline demand of today will be met from motor benzol, as this term is now used.

Industrial Alcohol

Industrial alchohol as a motor fuel was discussed by B. R. Tunison, of the Industrial Alchohol Co. The present output of this product, which might conceivably be diverted into motor-fuel use if the requirements for solvent and chemical operations were ignored, is approximately the same order of magnitude as the total available motor benzol. The estimated industrial-achlohol plant capacity of the entire country is only about 100 million gallons per year, or about 2½ per cent of the motor fuel requirement of today.

The carburetion characteristics of alcohol, benzol and gasoline were contrasted by Dr. Tunison, and it was shown why the blended fuels including some of each of these three constituents could be expected to give superior motor performance. The great advantage of alcohol for motor use is that it fires quickly, but does not increase its rate of burning as much during combustion as do the other motor fuels. Moreover, the range of full air ratio for successful operation is wider with alcohol than with either benzol or with gasoline. Alcohol also permits much higher compression ratios, thus giving large possible increase in efficiency under the most favorable conditions, but it is not under normal circumstances best applied alone. It lends itself rather to the blended-fuel application.

Forest products as a source of alcohol for motor fuel were discussed in a paper prepared by C. Sherrard, of the United States Forest Products Laboratory, presented by Dr. H. F. Betts, of the Forest Service. The possibilities of alcohol production from wood waste were fully set forth. It was pointed out that this was one of the most promising sources of cheap raw material for industrial-alcohol production. The estimates indicated that about fifteen gallons of alcohol could be expected under ordinary conditions of plant operation per ton of wood treated. The investigations of the Forest Products Laboratory on the best conditions for cooking of wood pulp with acid as the initial stage in alchol production were also discussed in this paper.

Austria's monthly requirements of coal are estimated to be 1,156,600 tons, of which only about 15 per cent can be produced within the country itself.

Practical Refrigerating Engineers Meet in Chicago

DECEMBER 13 to 16 at the Hotel Sherman, Chicago, the National Association of Practical Refrigerating Engineers held its eleventh annual convention. The attendance was exceptionally good, coming principally from Kansas City and the states of the Southwest, where the association was formed. The program was so full that it was difficult to work in all the papers scheduled. The new Chicago subordinate organized last year is to be congratulated on the arrangements made for the convention and credit is due President Kloss, of Kansas City, for his businesslike conduct of the proceedings.

It should be stated that the association is rapidly gaining headway in the refrigerating field. With a Kansas City chapter added two years ago and a large subordinate organized in Chicago in 1920, it is the intention to branch out still more during the coming year. With Philadelphia chosen as the next convention city the rich refrigerating territory of the East is to be invaded and there are high hopes of enlarging what was originally a Southern organization into a broad national body thoroughly representative of the practical refrigerating engineers of the entire country and devoted to their education and general betterment.

At the first session Monday the usual addresses of welcome, the responses and routine business were followed by a paper on "Combustion," by Joseph W. Hays, who reviewed briefly the elementary theories of combustion and spoke of the losses that might occur. It was his thought that there was danger of making the record system too complicated and that instruments were of no avail unless their indications were carefully analyzed and digested. In obtaining combustion efficiency about 10 per cent was due to instruments and 90 per cent to operation. The discussion on the paper turned to the proper height of the boiler above the grate, the height of the bridge wall, the choice of baffling, whether horizontal or vertical, when burning oil or coal, and other practical problems.

Powdered Coal and Its Application to Industry

Milton W. Arrowood talked on powdered coal. He called attention to its application in various industries and its burning in boiler furnaces. In this connection he emphasized the importance of mixing the pulverized coal and the air for combustion in proper proportions before the fuel reached the furnace, cutting down in this way the large volume now considered necessary to receive the gases of combustion and to give the proper time interval for burning. With a proper mixing device less excess air would be needed in the furnace, reducing the loss in the flue gases, and by reducing the volume of the gases, giving a longer time interval for the boiler to absorb the heat. The fuel from the mixing device was injected horizontally into the furnace at low velocity. There was no impingement on brickwork and no formation of slag on the tubes. In view of the fact that each particle of coal requires for combustion eight to ten thousand times its own volume in air, the speaker pointed out the importance of mixing the coal and air outside the furnace to avoid the probable stratification that would take place when this mixing was attempted in the furnace. The suggestion was offered that ice plants might enter a new field by pulverizing coal for their own use and for outside consumption, as it was the speaker's opinion that powdered coal would be widely used in the near future, especially if it could be supplied as readily as other forms of fuel.

George H. Trout, director of the Smith Gas Engineering Co., gave an interesting address on "Gas Power for Ice-Making and Refrigerating Machines." The fields for gas power were reviewed and mention made of the limitations imposed on the cost of the prime mover by the load factor of the plant. Reference was made to the Smith gas producer as recently perfected, its ability to gasify bituminous coal, lignite or most any kind of fuel, the producer capacity in service and records for length of operation without shutdown. One producer had operated continuously for 280 days, and mention was made of a gas engine that had given continuous service for 84 days. With producer gas utilized by a gas engine as high as 25 tons of ice per ton of coal had been produced. From a ton of lignite 12 tons of ice had been made.

At the Tuesday morning session "Oil Engines as Applied to Refrigerating Machinery" was the topic discussed by J. D. Harper, of the Fairbanks-Morse Co. In making a choice of prime mover the selection was a problem to be decided for each individual plant. Location near an oil field was often a determining factor and there were merits in electric drive that should not be overlooked. In the past the oil-engine manufacturer had dwelt too much on theoretical efficiency and not enough on durability and records of service in refrigerating plants. There had been a great advance in the modern oil engine and its use had been extended.

For units exceeding 400 hp. the prime mover to adopt was the Diesel engine, the speaker claimed, and where the power requirements were 300 hp. or less, or where the load factor was such that the total power might be separated into units of this size or less, the surface-ignition engine gave the best results. It was usually a two-cycle valveless machine of staunch construction and had the advantage of using dirty oil, such as American fuel oil, with minimum attention. As to reliability, citation was made of engines that had run from 50 to 250 days without stopping. The operating cost ranged from ⅜ to ½c. per horsepower-hour, so that in order for purchased current to compete it must be bought at ¾c. per kilowatt-hour or below.

The Unaflow Steam Engine

In an elementary talk Robert Cramer explained the principles of operation of the Unaflow steam engine, illustrated its construction, and showed how its remarkably flat steam curve was due to the elimination of cylinder condensation. One of the essential requirements was that the cylinder heads should be steam-jacketed. Steam rates ranged from a shade over 10 lb. to 23.5 lb. per indicated horsepower-hour. Owing to the high uniform economy over a wide range of load, the Unaflow engine had reclaimed part of the steam-engine field. The compound engine could be built to give better economy at a particular load, but with only slight variations the efficiency dropped rapidly, so that for general service the Unaflow engine maintained a much higher average efficiency.

Thomas C. McKee, representing the Carbondale Machine Co., traced the development of the high-speed ammonia compressor which had been made possible by the use of the feather valve. The merits of the feather valve were brought out and details given on the construction, lubrication and general advantages of the compressor. In the discussion the fact was brought out that more clearance was required than in the old slow-speed machines. A loss in efficiency, however, was not sustained as it was merely a case of speeding up the compressor one revolution per minute to maintain the same economy. The extra gas gave back as much energy in expanding as was required to compress it.

Following was an interesting paper on the "Present Status of the Two-Stage Ammonia Compressor," by Harry Sloan, advisory engineer of the Vilter Manufacturing Co. Introducing the subject, Mr. Sloan reviewed the evolution of the two-stage air compressor and the application of the same principles to refrigeration. There had been certain developments up to 1880, when the question of compounding ammonia compressors was brought to a standstill, as it was generally considered that the higher economy did not more than offset the additional overhead on the initial investment. The general use of booster outfits for low-temperature work

finally gave impetus to the movement, so that eventually D. I. Davis brought out the two-stage ammonia compressor. The advantages of the machine as well as those of the plate valves employed were enumerated, and the construction shown by numerous slides. Practical results from machines in service showing high economy were given. The gain in efficiency from the compound compressor was due to the lower temperature range per cylinder and to intermediate cooling. A 20 per cent saving in power per ton of refrigeration was readily possible and a steam rate of 24 lb. per ton of refrigeration had been obtained.

At the Tuesday afternoon session H. T. Whyte, superintendent of ice factories of the Consumers Co., summarized briefly the results obtained by adding a Voorhees multiple effect device of two of the company's ammonia compressors. This device admitted suction gas to the compressor cylinder at two different pressures, the low-pressure gas entering first and eventually the high-pressure gas, giving the cylinder a denser charge and increasing from 25 to 35 per cent the theoretical capacity of the compressor. In actual operation in the plant there has been a diminution of 3 per cent in the power required per ton of ice and an increase of 20 per cent in ice produced. The machines were electrically driven and required 47.6 kw.-hr. per ton of ice.

C. W. Koehler, general engineer, Booth Fisheries Co., traced the cycle of operation in an absorption system and brought out many points that would effect economy in operation. Gilbert Sellers, chief engineer of the South Chicago Ice Plant, spoke on the manufacture of raw-water ice, giving the results of his early work in this line with a small experimental plant of his own making and later with one of the early raw-water plants remodeled according to his own design. The difficulties encountered were numerous, but excellent results had been obtained until air agitation and treatment of the water by the cold process gave nearly as good results in a simpler way.

Electrical Drive for Refrigerating Machinery

"Electrical Drive for Ice-Making and Refrigerating Machines," by William J. Bray, sales engineer of the General Electric Co., was the first paper Wednesday morning. It was a comprehensive treatment covering the entire electrical installation. Particular attention was given to slip-ring induction motors and to the advantages of synchronous-motor drive. In comparing slow-speed belted compressors with direct-connected high-speed compressors equipped with plate valves, the obvious advantages were saving in floor space, elimination of belt trouble, and higher efficiency. At full load the smaller synchronous motors used had shown an efficiency of 91 per cent. In machines of 800 or 1,000 hp. capacity the efficiency increased to 94 per cent. Below 100 hp. slip-ring induction motors were desirable.

W. J. Hughes, of the International Filter Co., gave an elementary talk on the "Treatment of Water for Raw-Water Ice." Following a simple explanation of the properties of water and its chemical constituents, he showed the relation of water purification to fuel conservation. Comment was made on the different salts in water with which it is necessary to contend when making raw-water ice. Analyses of water before and after lime treatment were given. Softening water by the Zeolite process was shown to be unsatisfactory for ice making. The character of the different scale-forming ingredients in the water and the losses caused thereby were given brief attention, and in conclusion details on the construction and operation of International softeners.

F. C. Pedley, of Dubuque, Iowa, brought out various factors in the engine and boiler room affecting economy in ice-making and refrigerating plants. He was followed by Charles M. Gilbert, president of the Midwest Engineering Co., who enumerated briefly the things to do when overhauling and rehabilitating ice plants.

On Wednesday afternoon the first order of business was the election of officers, with the following results: President, C. W. Koehler, Chicago; first vice-president, F. L. Brewer, West Tulsa, Okla.; second vice-president, J. E. Lawrence, Dallas, Tex.; secretary, Edward H. Fox, Chicago; treasurer, W. R. Ilch, Kansas City; sergeant at arms, Roy Noyes, Chanute, Kan.; board of directors, E. J. Dean, Philadelphia; Norman Register, Dallas, Tex., and W. W. Stevens, Los Angeles, Cal.; chairman publicity committee, E. H. Fox, Chicago; chairman educational and examining committee, J. E. Porter, Oklahoma City, Okla.

Refrigerating Standards

The remainder of the session was devoted to refrigerating standards. J. E. Porter made a strong plea for the standardization of ammonia fittings. With some 25 to 30 different companies manufacturing ammonia fittings, each company is putting out a different fitting and many of them have changed the design several times, with the result that the situation is growing steadily worse instead of better. It was his recommendation that the association unite with the American Society of Refrigerating Engineers and the various ice-manufacturing associations to bring about standard conditions in this field. In the discussion a letter was read from the secretary of the American Society of Refrigerating Engineers reviewing the efforts already made by that society without avail. A representative of the Crane Co. called attention to the fact that his company had adopted the extra-heavy steam standard so that refrigerating engineers already had a standard from the flange, bolting and metal thickness points of view.

A motion was made that the incoming president appoint a committee of five to study the standardization of fittings, and a resolution was passed that the society express its opinion that all ammonia valves and fittings be standardized, so that valves and fittings of all makers would be interchangeable, a copy of this expression to be sent to all manufacturers of this equipment.

For the general interest of the association Gardner T. Voorhees spoke of the work of the joint committee of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers in establishing a standard ton of refrigeration, 288,000 B.t.u., and a standard commercial ton of 200 B.t.u. per minute. Later on attention was called to the code for the regulation of refrigerating machines and refrigerants tentatively adopted by the American Society of Refrigerating Engineers. Requests were made for copies of this code, instructions given that the secretary mail to each member a copy for study and that the chairman of the standards committee represent the association on the joint code committee of the various societies interested.

H. C. Johnson, inspector, department for the inspection of steam boilers, steam and cooling plants, City of Chicago, reviewed the Chicago code for the installation and regulation of refrigerating machinery. He gave particular attention to the penalties, rules applying to cylindrical shells, and to the ten points requiring specific attention when inspecting the plant.

Local Examining Boards

On Thursday morning J. D. Porter, chairman of the educational committee, urged that the association create local examining boards in each of the subordinates. A personal interview would give a better line on the ability of the applicant and facilitate the issuing of certificates. The National Examining Board was to be retained and would issue the certificates upon recommendation from the local board. The suggestion was favorably received and will be put into effect. The rest of the day was spent in excursions to plants of interest to refrigerating engineers.

In the way of entertainment a theater party was tendered to all members by the Chicago Subordinate on Monday evening. There was a smoker and entertainment Tuesday evening at which music and vaudeville acts were interspersed with motion pictures showing the manufacture of wrought-iron pipe and the production of petroleum lubricants. R. A. Griffin, of the Reading Iron Co., presented the former and C. M. Larson, of the Sinclair Refining Co., showed the lubricant films. On Wednesday evening was held the annual banquet, which was an unqualified success. Complimentary to an older association closely allied in the work of educating the engineer, Fred Raven, secretary of the National Association of Stationary Engineers, was requested to act as toastmaster.

American Engineering Council Holds First Meeting

Herbert Hoover, president of the Federated American Engineering Societies, presided at the Executive Board meeting held in New York, Dec. 17, of American Engineering Council, which is the governing board of the Federation. Every member of the Council was present with the exception of A. M. Greene, and two new members of the board were elected—W. B. Powell, of Buffalo Engineering Society, representing District No. 1, New York and New England States, and Gardner S. Williams, Grand Rapids Engineering Society, representing District No. 2, Michigan, Wisconsin and Minnesota.

The president appointed standing committees: On Procedure, Constitution and By-Laws, Publicity and Publications, Membership and Representation, Finance, and Public Affairs.

In discussing the program of the Council immediately ahead, Mr. Hoover stated that he had called engineers together in various cities he had visited lately, and that he found that the general desire of engineers everywhere was to join in the Federation movement, but that the general trend was for territorial organization, as distinguished from national organization. One of the stumbling blocks in the way of these territorial organizations' joining the national organizations was the question of dues. Another complexity was that individuals hold memberships in more than one society. For example, the Western Society of Engineers has about four thousand members, of which three thousand are already members of national societies who have affiliated with the Federation. Mr. Hoover also stated that there had been some opposition to the Federation based on the constitution, but that the question of territorial organization was the most important, and he suggested that a committee should be appointed to canvass and help the situation. This question was discussed and referred to a special committee, which will include the six district delegates.

As a step forward in co-ordinating various intersociety activities already established, the necessary action was taken to make it possible for certain of the activities of Engineering Council to be taken over by the new organization. As soon as the United Engineering Societies have passed officially upon Engineering Council's proposed action to transfer the work of its committees who have not yet finished their work, the president will appoint the necessary committees of American Engineering Council to take over this work. At the meeting of Engineering Council held in Washington there was harmony of all the member societies to this end. In this connection action was taken to amend section 9, paragraph 6 of the by-laws so that members of committees can be selected from societies other than those at present members of the Federation. Civil engineers and engineers in other bodies not at present affiliated with the Federated American Engineering Societies can, because of this action, co-operate in the committee work.

The four so-called founder societies in addition have been associated in a common employment service, and American Engineering Council has offered to take over this service as a part of its function.

American Engineering Council in this meeting voted not to affiliate with the United States Chamber of Commerce. It was the thought of the meeting that the Council could make its best contribution to the public by acting independently of other organizations.

The Council authorized the appropriation of one thousand dollars as an initial fund to carry on publicity work, and the Committee on Publicity and Publications was given authority to set up a board of engineering editors.

It was voted that full expenses of members of the Executive Board for attendance at meetings would be paid.

A special committee reported on candidates for permanent executive secretary of the organization, but no final action was taken at the meeting.

There was a general feeling expressed that the meetings of the board should be held at different centers, and the place of the next meeting, which will be held Feb. 11, was after considerable discussion left to the discretion of the president.

Annual Meeting of the American Society of Refrigerating Engineers

The annual meeting of the American Society of Refrigerating Engineers was held at the Hotel Astor, New York City, Dec. 6-8. The Monday morning session was devoted to the business of the society, the Council report being received and the officers for the new year elected. Fred Ophuls, of the engineering firm of Ophuls, Hill & McCreery, was elected president. Mr. Ophuls is one of the most prominent refrigerating engineers in the country and has been a member of the Council for a number of years.

At the afternoon and evening meetings a number of papers were presented and discussed. Among these were papers on the "New Ammonia Tables of the Bureau of Standards," and on "Total Heat Diagrams and Clearance Volume Meters," which will appear in *Power*.

The Tuesday sessions were devoted to papers on practical refrigerating problems. A paper by H. C. Newlean on concrete brine tanks occasioned lengthy discussions. It was borne out by means of numerous diagrams that the sand to gravel ratio and the water percentage were the determining factors in the construction of concrete tanks. The speaker stated that the gravel and sand should be screen-tested to determine the correct ratio. He claimed that failure to secure proper proportions reduced concrete compression strength as much as 50 per cent.

The subject of pipe welding was covered by two papers, one on the "Thermite Process," by R. L. Browne, and one on "Electrical Welding as Applying to the Resistance Method," by J. H. Gravell. It appeared from the paper that electrical welding of pipe was practical only in cases where a large number of joints were to be welded. Its most successful application was stated to be in plate welding. Thermite welding was stated to be uniformly successful in the welding of pipe. A demonstration of the case of the thermite process was made before the society, pipe ends being welded together in a few seconds. The joints were free from internal decrease of area and were apparently perfect. The cost per weld was said to range from one to two dollars, depending on the pipe size, the size range being from one to six inches.

The question of "Pressure Relief Diaphragms" was taken up and fully discussed. The increasing popularity of the small family refrigeration machine compels the incorporation of some safety device in the design. Diaphragm relief valves seemed to be considered most feasible, but the questions of diaphragm form and support are still matters of experimentation. The author of the paper, H. E. Willsie, rather inclined to favor the design where the support had rounded edges and the rupture occurred in the center of the diaphragm.

The final sessions were taken up by the discussion of papers on "Pipe Corrosion," "Use of Refrigeration in Air Conditioning," "Brine Propellers" and "Electric Rates." The paper on pipe corrosion in refrigeration systems aroused much comment. The author, F. N. Speller, stated that as the result of a great many tests extending over a number of years it was proved that steel, iron and piled tubes corroded at the same rate. He further discussed the causes of the corrosion in piping and felt that it had been amply proved that the free oxygen in the pipe lines caused the trouble. This had been solved in many instances by inserting iron perforated sheets in a tank connected to a pipe system. The free-oxygen coming into contact with these sheets before entering the pipe lines produced their corrosive effect on the sheets.

Two or three members took exception to the statement as to the uniformity of corrosion in steel and iron tubes. It was claimed that in certain plants the steel condenser tubes were destroyed in half the time required by the iron tubes. Mr. Speller felt that conditions other than corrosion or inequality in exposure to corrosive agents caused this decrepancy in life.

Plans are being made to utilize the peat in the moorlands of Esthonia and Latvia. These bogs have a total area of 4,300 square miles. It is estimated that coke from this source will cost but one-fifth as much as imported coke.

Power House Engineer Wanted by the Government

The United States Civil Service Commission has announced an open competitive examination for power-house engineer. A vacancy at the United States Military Academy, West Point, New York, at $1,200 a year, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion. After six months' satisfactory service appointees may be allowed the increase granted by Congress of $20 a month. The duties of the appointee will be to take charge during his watch of the plant, consisting of boilers of 3,000 hp. and 1,500 kw. generating capacity, in Corliss d.c. machines and motor generation a.c. machines, and to make minor repairs. Applicants must have had at least four years of general power-plant experience, of which at least one year must have been in responsible charge. Each completed year of a mechanical-engineering course in a college or technical school of recognized standing will be accepted as equivalent to not more than nine months of general power-plant experience. Applicants should apply for form 1800, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.; to the Secretary of the United States Civil Service Board, West Point, N. Y., or Custom House, New York, N. Y. Applications must be filed with the Civil Service Commission, Washington, D. C., prior to the hour of closing business on Jan. 4, 1921.

Overheard at the A. S. M. E. Convention

"Well, well, this doesn't look much like the old Thirty-First Street quarters, does it? Do you remember the way we used to drop in there in the morning after a night on the zigzag and breakfast at the Murray Hill and tell Miss Parker, or Frank Hoadley or Robert that we wanted a room, thereby setting our expense account back a whole dollar? That reading room certainly was about the quietest and coziest place in New York to look up information in. And if I remember rightly we felt that with our few hundred membership we were doing some pretty good things and had a pretty important organization even if we hadn't as yet begun to rob the cradle. 'Member the dances at Sherry's and the night when the Admiral danced three times with the missus and you were going to sue the United States Navy? That punch certainly did have a good deal to answer for. Of course I suppose things are all right as they are now, but I really would like to drop into the little back room of the old Engineers Club on the avenue and have a little—yes, dear, yes, I'm coming right along. So long, Bill, see you later."

Wages for Government Employees

In the revised Reclassification Bill, which is now under preparation, it is understood that the following basic rates have been agreed upon for power-house employees in the Government service: Power-plant, central-station, service-station, or pumping-station engineman, $1,680 per annum; hoisting engineman, $1 per hour; supervising engineman, $1,920 to $2,160 per annum; assistant chief engineman, $2,280 to $2,520; chief engineman, $2,700 to $3,060; fireman and assistant electric substation operator, $1,200 to $1,300; portable boiler fireman, $1,260 to $1,380; boiler cleaner, $1,320 to $1,440; oiler, water tender, assistant gas-engine operator, $1,380 to $1,500; assistant engineman, $1,680, and gas engineman, refrigerator engineman, $1,680 per annum.

How the A. S. M. E. Boiler Code Works in Ohio

Out of about 20,000 boilers in use in the State of Ohio there were but three explosions in the fiscal year ended June 30, 1920. The cause of failure in one of these cases was the punching and drifting of rivet holes in the construction of the boiler; this practice was permitted at the time this boiler was built, but has since been prohibited in Ohio. Another explosion was due also to careless construction, made possible by incorrect design; the Ohio Board of Boiler Rules is taking steps toward the elimination of this particular type of boiler by the reduction of its safe working pressure. A third explosion resulted from the use of a boiler that had not been inspected and was used in violation of the Ohio boiler inspection law. If this boiler had been properly inspected safety devices would have been insisted upon that would have prevented the explosion.

These facts are set forth in the annual report of the Division of Boiler Inspection of the Industrial Commission of Ohio. It may be mentioned in this connection that the State of Ohio has adopted the A. S. M. E. Boiler Code and has made it a part of its boiler-inspection laws.

A. A. E. Growing Rapidly

The results of the membership campaign recently conducted by the American Association of Engineers, now officially tabulated, show that 3,735 applications were received during the drive lasting from Sept. 15 to Oct. 30. In addition more than the usual number of applications has come in since the campaign, owing to the impetus of the drive. The membership on Dec. 8, 1920, was 23,004. The association now has 240 chapters and clubs and maintains offices in thirteen cities: New York, Washington, Pittsburgh, Boston, Detroit, St. Louis, St. Paul, Omaha, El Paso, San Francisco, Los Angeles, Seattle and Portland. It has state assemblies in ten states: Nebraska, Montana, Ohio, Washington, California, North Carolina, Illinois, Arizona and Tennessee, and state chapters have been established in Nevada, North Dakota, Minnesota, Idaho and Oregon.

The paper on "The Constitution and Properties of Boiler Tubes," which was abstracted in Power for Dec. 14, has been revised by its author. Inasmuch as a mistake mentioned by him was carried into the abstract, its correction is noted here. In the 19th line of the article as it appeared in *Power*, the phrase "sodium carbonate" should be changed to "calcium carbonate."

New Publications

STUDY OF THE RELATION BETWEEN THE BRINNELL HARDNESS AND THE GRAIN SIZE OF ANNEALED CARBON STEELS. Bureau of Standards Scientfic Paper 397. By H. S. Rawdon and Emiles Jimeno-Gil.

This paper deals with material and methods, microscopic examination, hardness determination and growth.

CRANES DIRECTORY OF CLASS, TRADE AND TECHNICAL PUBLICATIONS AND MARKET DATA BOOK. Published annually by G. D. Crane, Jr., 417 South Dearborn St., Chicago, Ill. About 500 pages, cloth binding. Price, $5; in advance of publication, $3.75.

This is the first edition of the book and is still on the press. It lists all the business publications of the United States and Canada, giving circulations, rates, type-page sizes, closing dates, etc., and makes a market analysis of each trade, profession and industry. The book is designed to be of value to advertisers and readers of trade and technical papers.

COAL-SAVING IN THE CHEMICAL INDUSTRY. By David Brownlie. Reprinted from *The Chemical Trade Journal and Chemical Engineer* for August-September, 1920, by Brownlie & Green, Ltd., technical chemists and engineers, 2 Austin Friars, London, E. C. Paper; 15 pages, 8½ x 11 in. Price, 2s. 6d.

This pamphlet gives the results of investigation that have been carried out by its author through a period of about nine years in the steam-boiler plants of sixty chemical works in Great Britain. The writer points out that the net working efficiency of these sixty plants is only about 58 per cent, and he believes that this could be easily increased to about 72½ per cent. Results of a number of tests are given, and explanation is made of various methods of scientific control of boiler plants.

SLUSHING OILS. Technologic Paper No. 176, prepared by Percy H. Walker, chemist, and Lawrence L. Steele, associate chemist of the Bureau of Standards of the United States Department of Commerce. Paper binding, 23 pages, 7 x 10 in.

This booklet contains the results of experiments recently conducted by the Bureau of Standards, both in the nature of laboratory tests and exposure tests. The report shows that laboratory tests cannot be relied upon in every instance, but that they are valuable in certain cases. Requirements for slushing oils which are to be used for different purposes are discussed, and suggestions are given for easily made and effective mixtures. The booklet may be obtained by remitting 5 cents to the Superintendent of Documents, Government Printing Office, Washington, D. C.

PROCEEDINGS OF THE ANNUAL CONVENTION OF THE I. R. A. A.

Published by the Industrial Relations Association of America. A verbatim report of addresses and discussions heard at the annual convention, which was held in Chicago May 19-21, 1920. It should be of value to anyone who is strongly interested in the relations of capital and labor. Copies may be obtained from the Administrative Offices of the association in Orange, N. J.

SAFETY IN THE MACHINE SHOP

Prepared by the Travelers Insurance Co., Hartford, Conn. 188 pages, 6 x 9 in., paper bound. Sent without charge to anyone making a request for it to the Supply Department, Travelers Insurance Co., Hartford, Conn. This booklet is exceptionally well gotten up and treats in considerable detail of the prevention of accidents in the machine shop. It deals with plants both large and small and gives concrete suggestions for the safeguarding of workers in them. Four chapters of especial interest deal with infection from cutting oil, injuries from the use of hand tools, illumination and its bearing on accidents, and the employment of women. The book should be useful to anyone who is in responsible charge of machine tools.

Personals

L. K. Silleox has been advanced from the position of assistant general superintendent to that of general superintendent of motive power of the Chicago, Milwaukee & St. Paul Railway Co.

F. K. Copeland, president of the **Sullivan** Machinery Co., Chicago, Ill., has been named new national councillor of the Compressed Air Society of New York, to represent it in the Chamber of Commerce of the United States.

Harry N. Winner, formerly with the Johns-Manville Co. and for 17 years prominent in the Garlock Packing Co., has taken a position with the United States Rubber Co. as manager of the packing department, with offices at 1790 Broadway, New York City.

James T. Whittlesey, a graduate of Yale University and for twelve years chief engineer of the Public Service Electric Co. of New Jersey, has been appointed director of a new Pacific Coast branch of the Engineering Business Exchange, of New York City, with offices in the Chas. Spreckels Building, San Francisco.

A. W. K. Billings, of Barcelona, Spain, is making a brief business trip in the United States. Since 1912 he has been engaged in the extensive hydro-electric and other work of the Barcelona company, successively as manager of construction, managing director, vice president and consulting engineer. During the war he served with distinction in charge of naval aviation construction in Europe.

T. H. Ceperley, who for the past twelve years has been chief operating engineer of the power and substations of the Albany Southern R.R., has resigned his position on account of ill health. He will spend the winter in the South and will enter the electrical field again next spring. Mr. Ceperley was formerly with the Newburgh Light, Heat and Power Co. as chief engineer of the Newburgh plant, and was also with the Fonda, Johnstown & Gloversville R.R., in the same capacity.

Society Affairs

Cleveland Section, A. S. M. E., will meet Jan. 4 in the Hotel Statler to hear an address on "Recent Developments and Modern Tendencies in Machine Design," by A. L. De Leeuw.

St. Louis Section, A. S. M. E., will meet at the American Hotel on Jan 7. Fred Key, of the Key Boiler Equipment Co., will speak on "The Key Safety Handhole Cap for Water-Tube Boilers."

Waterbury Branch, A. S. M. E., will meet Jan. 3 in the Chase Co.'s Office Building, Waterbury. Captain Harry George will speak on "Mining Experiences of a Prospector," and moving pictures will be shown of the manufacture of Byers wrought-iron pipe.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will hold a meeting on Jan. 8 at which P. T. Vanderwaart, electrical engineer of the New Jersey Zinc Co. of Pennsylvania, will discuss "Power Factor Correction and Its Relation to Plant Operation."

Trade Catalogs

The M. H. Detrick Co., 155 East Superior St., Chicago, has issued an 8-page folder showing installations of its arches with Type "E" and Coxe Stokers. Layouts with leading makes of boilers are shown by pictures and diagrams.

The Consolidated Belting Co., Philadelphia, Pa., has brought out a new 24-page 6 x 9-in. catalog of "Hycalibre" belting. The usual specifications are given, together with practical hints and formulas to be used in ordering and applying belts. It is also announced in this catalog that the company can renovate worn-out belts at a nominal cost.

The Brown Hoisting Machinery Co., Cleveland, Ohio, is distributing its Catalog "K" for 1921, of electric and steam-driven cranes. This is an 88-page, **8 x 11-in.** booklet containing an unusually large number of good photographs depicting "Brownhoist" locomotive cranes for loading and unloading cars, excavating, handling ore, stone, sand, lumber, etc., and general use up to about twenty-seven tons.

The Illinois Stoker Co., Alton Illinois, has published a 50-page **10 x 7-in. catalog** on natural-draft and forced-draft mechanical stokers and Illinois arches. It contains a discussion of "Boiler and Furnace Efficiency" in which there are carefully worked-out diagrams; this section, together with the thoroughness with which the booklet goes into the subject of combustion control, gives it a value distinct from its function as a catalog.

COAL PRICES

Current mine quotations, with interesting comparisons, are given in the following tabulation:

	Nov. 1919*	Aug. 5 1920	Dec. 16 1920	Dec. 23 1920
Pittsburgh steam	$2.30	$10.00	$3.25	$3.75
Pittsburgh screened gas	2.30	12.00	3.75	4.50
Hocking	2.50	9.00	3.00	3.75
Franklin, Ill.	2.35	6.50	3.40	4.00
Indiana 4th vein	2.35	7.50	3.25	3.25
Eastern Ohio, No. 8	2.35	10.50	3.40	4.00
Fairmont	2.50	13.50	3.00	3.75
Kanawha	2.60	14.00	3.50	4.50
S. E. Kentucky	3.00	10.50	4.00	4.75
Western Kentucky	2.35	5.25	3.75	4.00
Clearfield	2.95	12.00	3.75	4.75
Cambria and Somerset	2.95	13.50	4.75	6.00
New River	2.70	14.00	5.00	5.00
Pocahontas	2.35			

*Government prices.

New Construction

PROPOSED WORK

Mass., Charlestown (Boston P. O.)—J. Rogers, Agt., 18 Tremont St., Boston, is having plans prepared for a 7 story industrial building on City Sq., here. About $300,000. F. O. Lewis, 30 Broomfield St., Boston, Archt. and Eng.

Mass., Holyoke—The School Bldg., Comn. is having plans prepared for a 3 story junior high school on Maple St. About $300,000. G. P. B. Alderman & Co., Alderman Bldg., Archt.

Mass., Holyoke—The School Comn. plans to build a 2 story grade school. About $250,000. Archt. not selected.

Conn., Hartford — Our Lady of Sorrows Church, Rev. H. Galvin, pastor, 85 New Park Ave., had plans prepared for a 75 x 170 ft. church including a steam heating system. About $250,000. O'Connell & Shaw, 18 Bovlston St., Boston, Mass., Archts.

N. Y., Brooklyn — The New York Telephone Co., 15 Dey St., New York City, had sketches prepared for a telephone exchange including a steam heating system, on Willoughby Ave., here. McKenzie, Voorhees & Gmelin, 1123 Bway., New York City, Archts. and Engrs.

N. Y., Rochester — Gordon & Kaelber, Sibley Block, will soon award the contract for a 9 story apartment hotel including a steam heating system on East Ave. J. A. Armstrong, 127 North Dearborn St., Chicago, Ill., Archt.

N. J., Trenton—The Sanitary Ice & Coal Co., Old Rose St., plans to build an ice cream storage plant and install equipment in same. W. B. Maddock, 42 Division St., Pres.

Pa., Raven Run—J. S. Wentz Co., Markle Bldg., Hazleton, plans to build a coal breaker here, incldng a boiler plant. About $150,000. G. S. Troutman, Markle Bldg., Hazleton, Archt. and Engr.

Md., Baltimore — S. T. Williams, 223 North Calvert St., is in the market for one 400-hp., three-phase, 60-cycle, 2,300-volt, about 600 r.p.m., electric motor.

Md., Baltimore—The Potomac Power & Development Co., c/o W. H. Stineman and A. M. Quick, Engrs., 418 Equitable Bldg., had preliminary plans and surveys made for the development of a project to include a dam, 1,200 ft. long and 65 ft. high and a main dam, 1,200 long and 22 ft. high; a 20,000-hp. power plant including the installation of five 5,000-hp. vertical turbines, generators, also a three-phase, 60-cycle, 13,200,-volt transmission line; a 30,000-hp. power plant including installation of five 700-hp. vertical turbines, and generators; flood gates, 18 x 30 ft., etc.

Md., Crisfield—The McCready Memorial Hospital, c/o G. F. Fyle and A. G. Brown, Archts., 109 North Dearborn St., Chicago, Ill., plans to build a hospital here, including a 42 x 45 ft. power house. About $200,000.

W. Va., Charleston — Kanawha County plans to build a county jail at Court and Virginia Sts. About $300,000. H. R. Warne, Masonic Temple, Archt.

N. C., Hickory—The Catawba Creamery Co. plans to rebuild packing plant and refrigerating rooms of creamery plant recently destroyed by fire. About $300,000.

Ga., Augusta — The Y. M. C. A., Green and 9th Sts., plans to build a 4 story Y. M. C. A. building. About $300,000. Murphy & Dunn, 331 Madison Ave., New York City, Archt., Y. M. C. A. Building Comn., Augusta, Engr.

Ga., Sandersville—The city plans to improve power house. About $40,000.

Ga., Tybee Island—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build 2 or more radio buildings here.

Fla., Gainesville — The city voted $30,-000 bonds for improvements to the municipal light and power plant.

La., New Orleans — The International Harvester Co., 606 South Michigan Ave., Chicago, Ill., plans to build a storage warehouse for the manufacture of twine and farm implements. Est. cost, between $3,000,000 and $6,000,000.

Tenn., Millington — The town plans an election to vote on $20,000 bonds for a new electric light and power plant.

O., Cleveland—The Bd. Educ., c/o F. G. Hogan, East 6th St. and Rockwell Ave., is having plans prepared for a 2 story addition to school, including a steam heating system, at East 146th St. and Kinsman Rd. About $250,000. W. R. McCormack, East 6th St., Archt.

O., Portsmouth—The Bd. Educ. plans to build a 3 story, 110 x 130 ft. high school including a steam heating system. About $400,000. A. Pretzinger, 1155 Reibold Bldg., Dayton, Archt.

O., West Park—The Bd. Educ., F. W. Featherstone, Clk., is having preliminary plans prepared for a 2 story school including a steam heating system in the Lenox Park district. About $250,000. Fulton, Taylor & Cahill, 8120 Euclid Ave., Cleveland, Archts.

Ind., South Bend—The Fraternal Bldg. Assn., C. Bell, Pres., plans to build a 6 story, 75 x 95 ft. fraternal building including a steam heating system at 109 East Wayne St. Freyermuth & Maurer, 308 South Michigan St., Archts.

Mich., Eloise — McFarlan, Maul & Lenz, Archts., 1259 David Whitney Bldg., Detroit, will receive bids until Dec. 31 for a 3 story, 100 x 200 ft. hospital and home including a steam heating system here, for the Wayne Co. Poor Board, c/o E. J. Jeffries, 1804 West Gd. Blvd. About $300,000.

Mich., Grand Rapids — The Catholic Central High School plans to build a 4 story high school including a steam heating plant. About $300,000. H. L. Mead, Archt.

Mich., Wakefield—The city had preliminary plans prepared for a 2 story memorial building. About $250,000. Herbst & Kuenzli, Caswell Blk., Milwaukee, Wis., Archts.

Ill., Chicago—A. Batik, c/o A. Charvart, Archt., 2621 Millard Ave., had plans prepared for a 3 story, 40 x 120 ft. ice plant. A steam heating system and ice making equipment will be installed in same. About $60,000.

Ill., Chicago — The West Chicago Park Comn., West Chicago Ave., will receive bids until Dec. 31, for 1 story, 55 x 370 ft. social center building including a steam heating system. About $250,000. Chatten & Hammond, 64 East Van Buren St., Archts.

Ill., Chicago — McCormick Estate, c/o Holabird & Roche, Archts., 104 South Michigan St., is having plans prepared for a 5 story, 101 x 135 ft. top addition to office building at 11 South La Salle St. including a steam heating system. About $1,250,000.

Wis., Taycheedah — The State Bd. of Control, Madison, will receive bids until Jan. 11 for furnishing equipment for the Industrial Home for Women here, including two 50-kw. d.c. engine type, 230-volt generating sets with duplicate balancer sets of 10-kw. each; switchboard and distribution system; two 600-hp. open type feed water heaters; two hot water converters, each for 20,000 sq.ft. of radiation; two boiler feed pumps; two hot water circulating pumps; two turbine-driven centrifugal circulating pumps, 300 g.p.m., 150 ft. head, or two direct-acting steam pumps, same service, etc. A. Peabody, Capitol, Madison, Engr.

Minn., Crookston — The Sisters of St. Benedict, c/o Bishop T. Corbett, plan to build a women's college. About $700,000. Archt. not announced.

Minn., Duluth — The Miller Memorial Hospital Board, Mayor T. W. Hugo, Chn., plans to build a 3 story, 100 x 200 ft. hospital including steam heating plant and mechanical ventilating system on 5th Ave. About $250,000. German & Jenssen, Exchange Bldg., Archts. and Engrs.

Minn., Litchfield—The Bd. Educ., J. T. Mullen, Clk., plans to build a 2 or 3 story high school including a steam heating system. About $300,000. Archt. not announced.

Minn., Minneapolis—The Bd. Educ., G. F. Womrath, Bus. Supt., 305 City Hall, is having plans prepared for two 2 or 3 story junior high schools including a steam heating system, at 6th St. and 13th Ave. and at 28th Ave., S. and 41st St. About $700,000. E. H. Enger, above address, Archt.

Minn., St. Paul—H. D. Loeb, 30 North La Salle St., Chicago, Ill., plans to build a 3 and 4 story, 100 x 157 post office here, including a steam heating system. About $750,000. J. P. Cowing Engr. Co., 30 North La Salle St., Chicago, Ill., Engr.

Kan., Wichita—The Midian Shrine, c/o Col. T. G. Fitch, Trustee, plans to build a 2 story, 200 x 200 ft. temple at 1st St. and St. Francis Ave. About $1,000,000. Archt. not selected.

Neb., Hastings—Hastings College is receiving bids for a 3 and 4 story, 80 x 190 ft. memorial hall including a steam heating system. About $400,000. Miller, Fullenweider & Dowling, 6 North Michigan Blvd., Chicago, Ill., Archts.

S. D., Watertown — The Bd. Educ., A. Herzel, Clk., plans to build a 2 or 3 story high school including a steam heating system. About $250,000. Archt. not selected.

Mo., St. Louis — The Mississippi River Commission, c/o Secy., 1311 International Life Bldg., will receive bids until Jan. 17 for furnishing 6 return-flue boilers for steamboat. Further information may be had on application.

Tex., Port Arthur—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received bids for an operating building and tower at the Naval Radio Station here, from Hyde & Baxter, 1311 G St., N.W., Wash., D. C., $6,558. 120 days; W. F. Martens, 53 Franklin St., Rochester, N. Y., $7,188. 100 days; Regan Constr. Co., 2 East Lexington St., Baltimore, Md., $9,988. 120 days. Noted Nov. 30.

Tex., San Antonio—The Hot Wells Mineral Bath & Hotel Co., South Piesa St., plans to build a dam for the development of 140 hp. Four turbines and other equipment will be required.

Okla., Tulsa—D. Hunt, c/o Hunt Co., 311-313 South Main St., is having plans prepared for a 10 story, 50 x 140 ft. office building. About $450,000. W. D. Vansiclen, 319 South Detroit St., Archt., A. F. Waseidewski, 1319 South Cheyene St., Engr.

Col., Denver—Bennett & Meyers, Taber Bldg., has purchased site at Bway., East 17th Ave. and Lincoln St. for a hotel. About $5,000,000. Archt. not selected.

Wash., Ocean Park — The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build a radio building here.

Ore., Astoria—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build a raido building here.

Cal., Pasadena—C. W. Koiner, Gen. Mgr. of the municipal light plant, announces that enlargements for the coming year will cost $300,000. The initial unit will include a boiler and appurtenances to cost about $50,000.

Cal., Pittsburg — The Contra Costa County Bank will receive bids until March 1 for a 1 story, 50 x 100 ft. bank at 4th St. and R.R. Ave. A heating system including a low pressure gas burning boiler will be installed in same. About $85,000. B. G. McDougal, 381 Bush St., San Francisco, Archt.

Cal., San Francisco—The Pacific Gas & Electric Co. applied to the Railroad Comn. for permission to issue $10,000,000 bonds to carry out its hydro-electric construction program, particularly for the Pit River projects of the Mount Shasta Power Corp., a subsidiary of the Pacific Company. It is also estimated that betterments and additions to the property of the Pacific Gas & Electric Company for the years of 1921 and 1922 will cost in excess of $20,000,000.

N. S., Halifax—The Nova Scotia Power Comn. plans to install 20,000 hp. for the benefit of this place and other municipalities and to develop additional power for the pulp and paper industry.

Ont., London—The Bd. Educ., c/o R. M. McElheran, Hydro Offices, is having plans prepared and will receive bids about Feb. 1 for three 2 story, 100 x 200 ft. high schools including steam heating systems. About $750,000. L. E. Carrothers, above address, Archt.

Ont., Tilbury — The Ontario Flax Co. plans to rebuild flax mill recently destroyed by fire causing loss of $75,000, and is in the market for machinery, engine, boiler, etc.

B. C., Prince George—C. Gordon, Pres. of Dominion Textile Co., 112 St. James St., Montreal, Que., is interested in a project which includes a pulp and paper plant to cost $6,000,000 and the development of water power on the Fraser River, here. Bids will soon be received.

CONTRACTS AWARDED

Mass., Lee—The Tayford Co., Inc., 154 Nassau St., New York City, has awarded the contract for a hydro-electric plant on the Housatonic River here, to H. W. Taylor, 154 Nassau St., New York City, at $150,000.

Conn., Meriden — The Home National Bank, 16 Colony St., has awarded the contract for a 4 story bank including a steam heating system to F. T. Ley & Co., Inc., 409 Main St., Springfield, Mass., at $350,000.

N. Y., Brooklyn — The Bureau of Yards and Docks, Navy Dept., Washington, D. C., has awarded the contract for the installation of a refrigerator for Building F at the Naval Hospital, here, to L. Mundet & Son, Inc., 24 Stone St., New York City, at $12,820.

N. Y., Brooklyn—The Y. M. H. A., c/o D. L. Rubinstein, 189 Montague St., will build an 8 story clubhouse, including a steam heating system, on South Rodney St. About $400,000. Work will be done by day labor.

N. Y., New York—The Consolidated Ship Building Co., 177th St., has awarded the contract for a 1 story, 35 x 35 ft. boiler house to Post & McCord, 101 Park Ave., at $15,000.

N. J., Bloomfield—C. F. Stiefel, 60 Orange St., has awarded the contract for a factory and power house to the White Constr. Co., 95 Madison Ave., New York City, at $80,000.

Pa., Philadelphia—The Amer. Ice Co., 6th and Arch Sts., has awarded the contract for a 2 story, 75 x 100 ft. ice factory to Monaghan & Losse, 3016 Chestnut St., at $120,000. Equipment for the manufacture of ice will be installed in same.

Ga., Trion—The Trion Co. will build a 3 story, 25 x 40 ft. power house addition. About $100,000. Work will be done by day labor. Noted Nov. 2.

O., Cleveland — Telling-Belle-Vernon Co., 3814 Cedar Ave., has awarded the contract for an 8 x 43 ft. boiler house addition to Uhl-Jaster Co., 1900 Euclid Bldg. One 200-hp. boiler will be installed in same. About $10,000.

O., Cleveland—Keith Theater Co., E. F. Alber, Mgr., 1564 Bway., New York City, has awarded the contract for a 20 story, 130 x 180 ft. theater and office building including a steam heating system at East 17th St. and Euclid Ave., here, to Lundoff-Bicknell Co., 5716 Euclid Ave., at $3,000,000.

O., Dayton — The City Comrs. have awarded the contract for installing heating and plumbing system in buildings on city workhouse farm to W. Haas Plumbing Co., 429 East 3rd St., at $29,875.

Ill., Dixon—The State Dept. of Pub. Wks. and Bldgs., Springfield, has awarded the contract for 2 hospitals here, including steam heating systems, to Simons & Dick, Bloomington, at $400,000.

Ia., Newton—The city has awarded the contract for a pump house including 2 motor-driven centrifugal pumps to A. Phelps Co., Knoxville, at $44,825.

Minn., Elk River—The Elk River Power & Light Co., M. E. Waterman, Secy., has awarded the contract for an additional unit at its power house to Siems, Helmers & Schaffner, 514 Guardian Life Bldg., St. Paul.

Cal., Santa Monica — The Santa Monica Ice Co., 12th and Colorado Aves., will build a 1 story, 32 x 50 ft. ice plant. About $8,000. Work will be done by day labor.

N. B., St. John—The Water Power Comn. has awarded the contract for dams on the Musquash River, 12 miles west of here, to the New Brunswick Constr. Co., at $248,000.

Ont., Chippawa — The Hydro-Electric Commission Toronto, has awarded contracts for transformers, electrical equipment, and other material needed in connection with power development here, to Westinghouse Co., Hamilton; Canadian General Electric Co., Peterboro; Allis-Chalmers Co. and John Englis Co., both of Toronto.

Now turn to the

SEARCHLIGHT SECTION

where you will find additional opportunities

Equipment Wanted
Business Opportunities
Pages 68 *to* 80

Agents and Salesmen
Equipment For Sale

Employment Opportunities
Power Plants For Sale, Etc.
Pages 68 *to* 80

Volume 52 New York, December 28, 1920 Number 26

POWER

FRED R. LOW, *Editor*

BOILERS AND FURNACES

Carrying the Load Without Stoker Shafting 1028

Instruments for the Boiler Plant 1030

EDITORIALS

925, 926

DISTRIBUTION CABLE MAINTENANCE—Labor Saving in the Plant—The Producer-Gas Engine—Co-operation Among Engineers' Associations—Regulation of the Load.

ELECTRICITY

How To Correct for Error in Instrument-Voltage Transformers 1011

BY J. B. GIBBS.

THIS ARTICLE TREATS of the regulation of voltage transformers, usual practice in transformer connections, phase angle and change in ratio of transformation and how wattmeter readings are affected by transformer error.

Some Distribution-Cable Experiences 1021

BY T. H. ARNOLD.

ELEVATORS

An Elevator with an Interesting History 1029

FUEL AND COMBUSTION

Economic Value of Coal—IV. Impurities in Coal 1012

BY B. S. MURPHY.

THIS IS THE LAST ARTICLE of the series, and in it the author explains how impurities in coal affect economy of operation.

Motor-Fuel Symposium 1034

GAS AND OIL POWER

The Solid-Injection Oil Engine 1008

BY EDGAR J. KATES.

IN THIS ARTICLE THE AUTHOR answers criticisms that have been made of the solid-injection type of engine, and enumerates some of its good points.

Eliminating Diesel Piston Fractures 1028

INQUIRIES OF GENERAL INTEREST

1031

RUNNING OIL ENGINE WITH CRACKED PISTON—Choice of Refrigerating System—Discharging Steam-Heating Returns to Common Receiver—Location of Direct Radiators—Vibration of Steam Gage for Lower Boiler Pressure—Content of Horizontal Cylindrical Tank.

NEW APPARATUS

Flexitallic Boiler and Flange Gaskets 1007

"Producto" Combustion Guide 1018

New Steam Turbine for Mechanical Service 1022

Gray System of Automatic Combustion Control 1023

News 1038

Construction News 1039

PIPING AND VALVES

Valve-Stem Packing Wrench 1029

Effect of Fitting on Flow of Liquid Through Pipe Lines 1032

BY DEAN E. FOSTER.

POWER PLANTS

Remodeling Old Power Stations — Boiler-Plant Improvements 1004

BY L. R. LEE.

HOW CAPACITY AND ECONOMY of an old boiler plant can be increased by improvements in coal and ash handling, furnace capacity, draft conditions, general condition of auxiliaries, etc.

PUMPS AND COMPRESSORS

Repairing an Ammonia Compressor 1024

BY ROLAND L. TULLIS.

REFRIGERATION

Refrigeration Study Course—XX. Erection and Operation 1015

BY H. J. MACINTIRE.

Practical Refrigerating Engineers Meet in Chicago 1035

Annual Meeting of the American Society of Refrigerating Engineers 1037

WATER POWER

Public Utility Development in California 1033

MISCELLANEOUS

Power for Nothing 1017

The Application of Babbitt Metals 1019

BY L. D. STAPLIN.

PRACTICAL SUGGESTION ARE GIVEN on grooving, alignment, anchorage, shrinkage and the results of casting the metal when it is overheated.

Packing Expansion Joints 1027

Keeping Stuffing-Box Packing Data 1027

Does a License Law Help? 1029

Gasket Caused Lubricating Trouble 1030

American Engineering Council Holds First Meeting 1037

Directory of Engineering Service 66

Searchlight Section 67-80

Index to Advertisers, Last Page

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Coal Age
Chemical and Metallurgical Engineering
Electrical Merchandising
Electric Railway Journal
Journal of Electricity
Ingenieria Internacional

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Change of Address—When change of address is ordered the new and the old address must be given. Notice must be received at least ten days before the change takes place.

Published Weekly. Entered as Second-Class Matter, Dec. 20, 1910, at the Post Office at New York under the Act of March 3, 1879.

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CIRCULATION OF THIS ISSUE, 27,500 COPIES

Moments with the Ad Editor

A Good Buy Letter for 1920

HOME OF "APPLE BLOSSOM" BRAND

Fesenmeier Packing Co.
PORK AND BEEF PACKERS

Huntington, W.Va. U.S.A.
November 13, 1920

"Power"
New York.

Dear Sirs:-

I should like to add my voice of approval to the many good things that have been said about "Power".

In buying equipment for Power Plants "Power" has paved the way for most Engineers & Purchasing Agents. Every "Power" the mail brings has "ads" of good Standard Equipment and the "Searchlight Section" with its used and secondhand machinery has proven to be a "bargain getter for those who purchase from it.

Below is a partial list of new equipment I have purchased recently, directly or thru supply houses here, but all due to "Power" ads.

Jeffrey Mfg. Co.	Ice Conveyor
Worthington Pump & Machinery Co.	2 Duplex Pumps
Lagonda Mfg. Co.	4-4" Air Drive Tube Cleaner
W.W.Nugent & Co;	2-Crank Pin Oilers
Economy Fuse Co.	Fuses
Smooth On Mfg. Co.	Smooth On
Homestead Valve Mfg. Co	2 Valves
S. F. Bower & Co. Inc.	4 Oil Tanks

In the last 18 months I have purchased $12,000 to $15,000 of equipment and supplies due to "Power" ads.

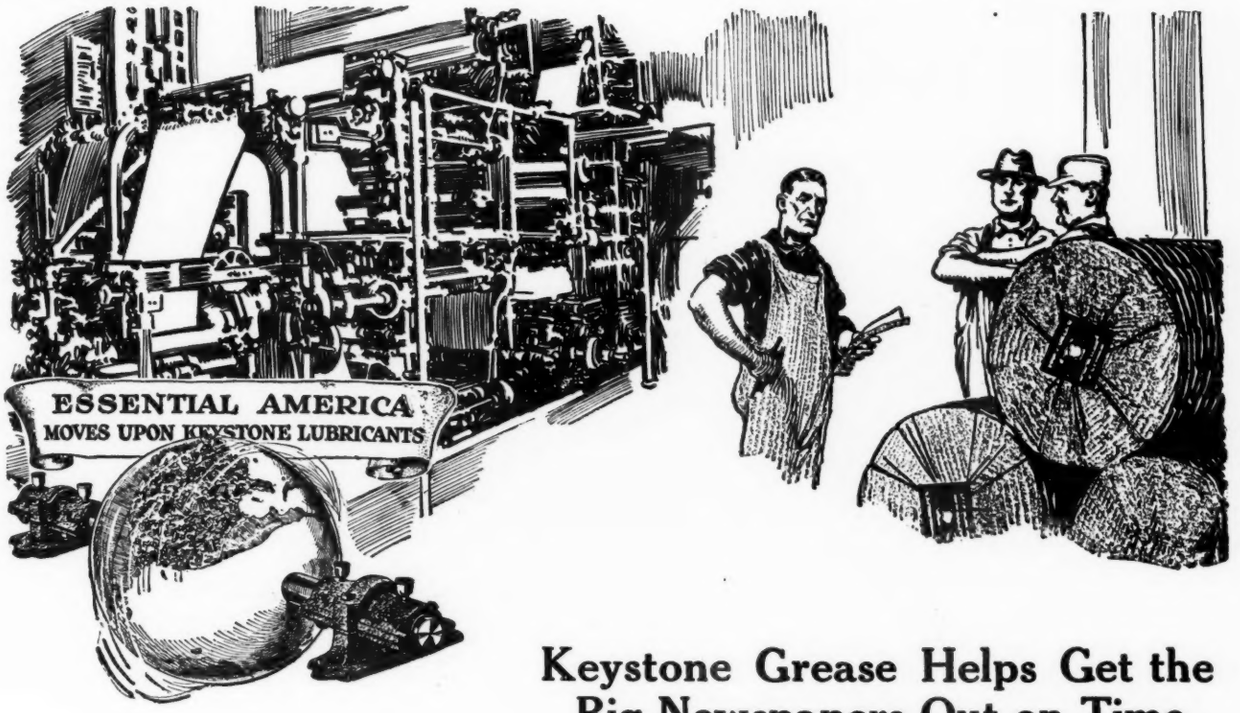
Yours very truly,

Chief Engineer.

FESENMEIER PACKING COMPANY

Year in, year out, for forty years POWER has met the needs of its readers, and promises still greater service for 1921

KEYSTONE LUBRICANTS



Keystone Grease Helps Get the Big Newspapers Out on Time

A fifteen-minute delay in getting any newspaper on the street may mean a tremendous loss in circulation. There is not a moment to lose—the big presses must start on time and their operation must not be interrupted until the entire edition is printed.

Shut-downs and "tie-ups" due to faulty lubrication are serious matters in the printing business—that's why **Keystone Grease** is now being used on the presses which print important publications.

Wherever you find Keystone Grease—in the press-room, the coal mine, the power plant or the steel-mill—you'll find it rendering a lubrication service brought to the highest point of development, the greatest degree of efficiency.

Let us explain our guarantee and arrange for a trial installation in your plant.

KEYSTONE TRADE MARK Reg. U.S. Pat. Off. GREASE

THE KEYSTONE LUBRICATING CO.

New York
Boston
Pittsburgh
Chicago

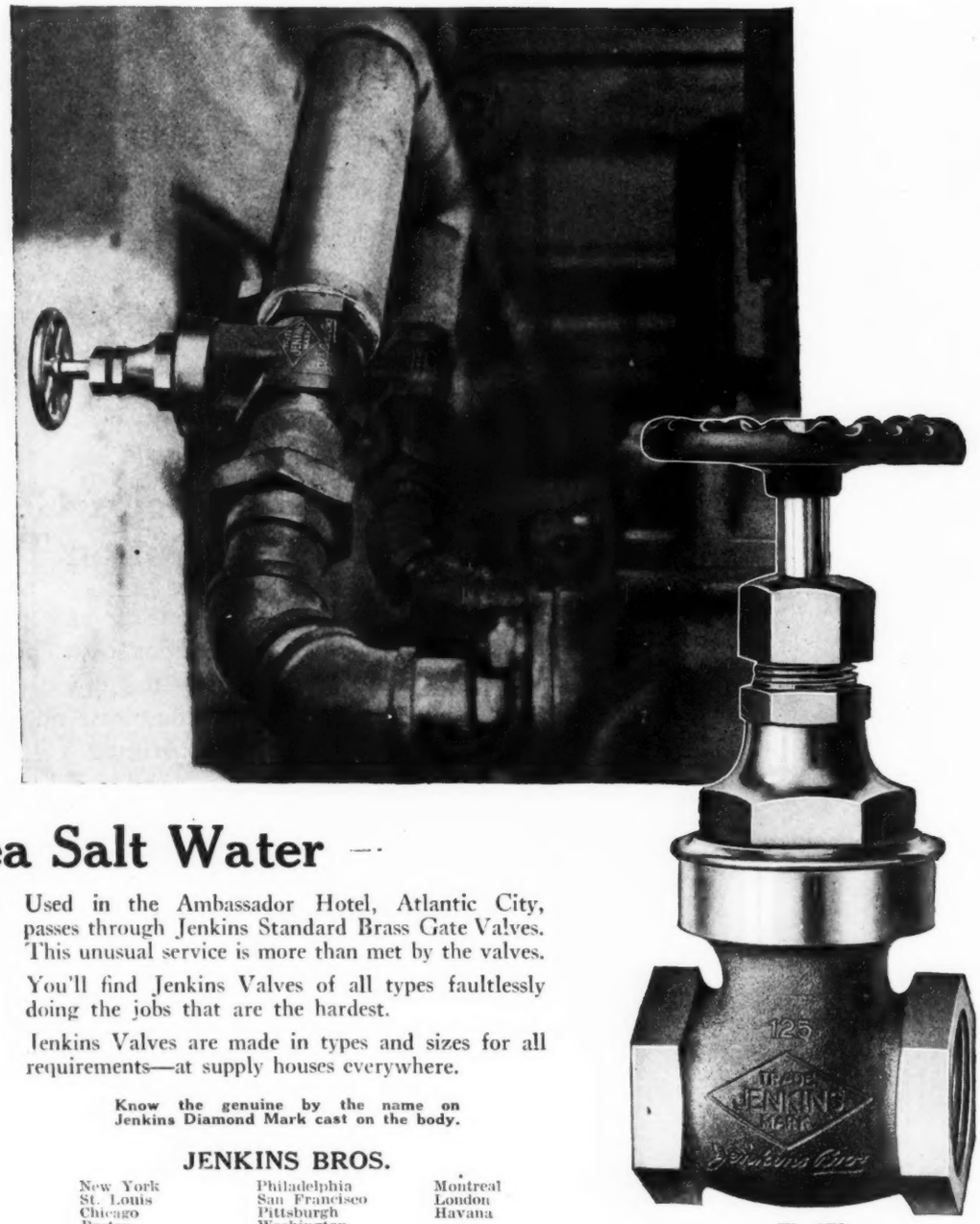
Executive Office and Works:
Philadephia, Pa.
Established 1884

Denver
St. Louis
San Francisco
Minneapolis
Houston

Continental European Offices: Marseilles, France

UNIVERSALLY KNOWN UNIVERSALLY USED

REG. U.S. PAT. OFF.
TRADE JENKINS MARK
Jenkins Bros



Sea Salt Water —

Used in the Ambassador Hotel, Atlantic City, passes through Jenkins Standard Brass Gate Valves. This unusual service is more than met by the valves.

You'll find Jenkins Valves of all types faultlessly doing the jobs that are the hardest.

Jenkins Valves are made in types and sizes for all requirements—at supply houses everywhere.

Know the genuine by the name on Jenkins Diamond Mark cast on the body.

JENKINS BROS.

New York
St. Louis
Chicago
Boston
Philadelphia
San Francisco
Pittsburgh
Washington
Montreal
London
Havana

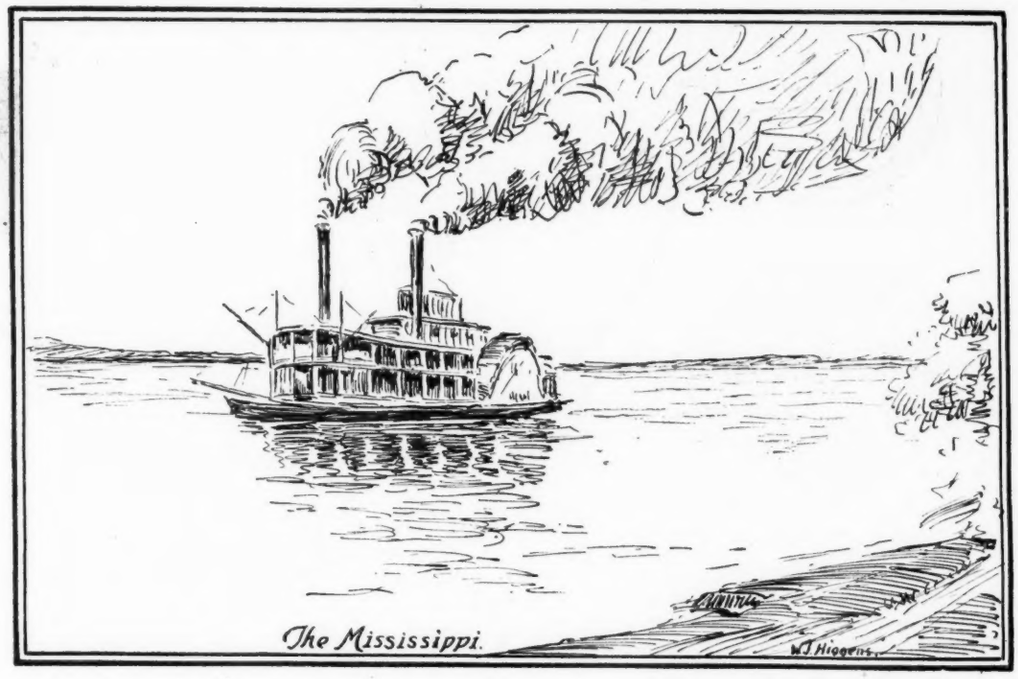
Fig 370

2253-J

Jenkins Valves
SINCE 1864

DEARBORN

INDIVIDUALIZED Water Treatment



All waters vary in composition— so must their treatment

Chemical Science makes possible the improvement of any water supply for steam making purposes.

Each supply calls for the correction of certain injurious elements, shown by analysis.

Dearborn Chemists can make your available supply of water safe and efficient.

We originated scientific methods of Water Treatment, and keep always ahead of our subject, with research and investigation.

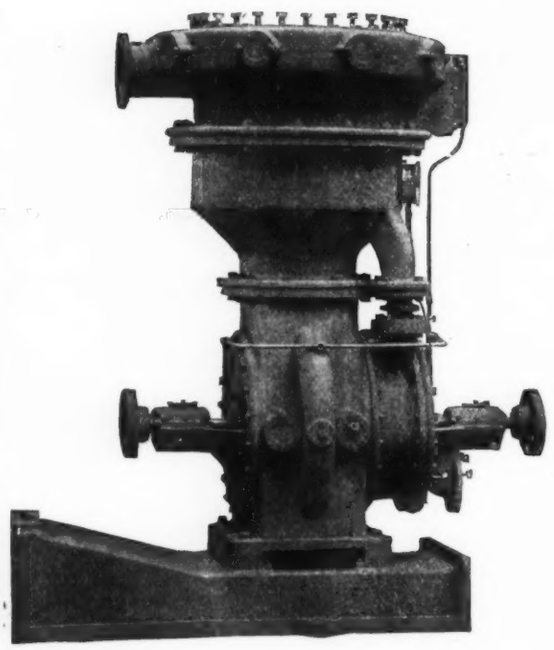
Send a gallon of your feed water for analysis with description of your plant and operating conditions. We will furnish you our report and recommendations without charge.

DEARBORN CHEMICAL CO.

General Offices, Laboratory and Works: Chicago
General Eastern Offices: 299 Broadway, New York.
Canadian Factory: 2454-2464 Dundas Street, W. Toronto.

Jet, Surface and Barometric Condensers

The safe and certain way to insure satisfactory performance is to approach condenser selection with an open mind, ready to be guided in your choice by the facts that develop from a study of plant conditions.



Facts For the Buyer—

If the designs of all condenser manufacturers were alike, there would be no choice from the standpoint of construction and dependability.

Today condenser buyers are considering more and more THE FEATURES UNDERLYING EFFICIENCY, RELIABILITY AND ECONOMY OF OPERATION.

The actual photograph of the mixing chamber of the Westinghouse Jet Condenser pictures an important buying feature.

The cool condensing water issues from the sides in finely divided fan like sprays which overlap and mingle in such a manner as to effect instantaneous condensation of the incoming steam. As a result of this effective mixture:—

(1). The temperature of the discharge is very close to that of the entering steam.

(2). The discharge pump handles less water and requires less driving power.

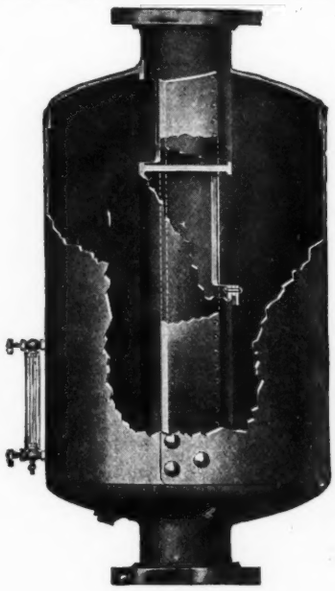
(3). As the temperature of the discharge is very close to that of the entering steam, you benefit by a boiler water of higher temperature.

From the standpoint of economy of operation, this is a feature of considerable importance to the condenser buyer.

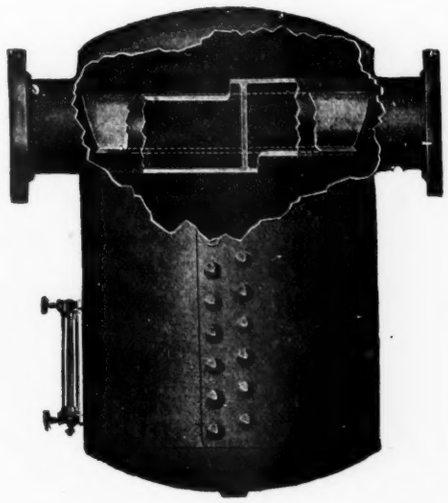
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

Westinghouse

10



Vertical Type



Horizontal Type

WELDERON
Receiver Separators

Every Steam pipe line is subject to vibration—and its expansion and contraction.

As may well be imagined the strain on the Steam Separator in the line is tremendous. Most Separators fail sooner or later from this cause.

But just note the "through pipe" construction of the Welderon Receiver Separators. The Steam line is CONTINUOUS through a Welderon.

In other words, the Welderon Separator is merely hung ON the line! It is subject only to the bursting force from steam pressure. It does not, like the ordinary separator, have to fight off every evil stress that hits the pipe line.

The through-pipe construction of the Welderon Separator means better, longer service.

Write for further facts about Welderon Receiver Separators. Made in sizes from 3 in. to 16 in.

ELLIOTT PRODUCTS
Condensers
Air Ejectors
Twin Strainers
Twin Filters
Feed Water Heaters
Steam Separators
Receiver Separators
Blow-Off Valves
Oil Filters
Steam Traps

ELLIOTT COMPANY

Pittsburgh, Pa.

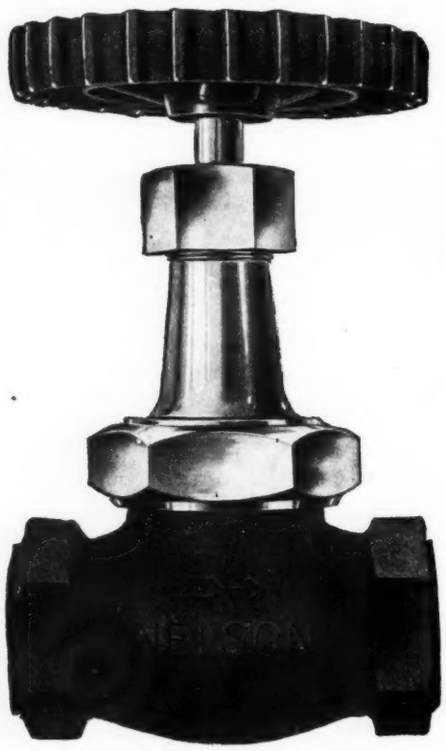
General Sales Office: Jeannette, Pa.

NELSON

Nickel Bronze Throughout

Renewable monel seat and disc

Cold-rolled monel stem



Long bonnet protects packing

Good for total temperature of 550° F.

No. 57

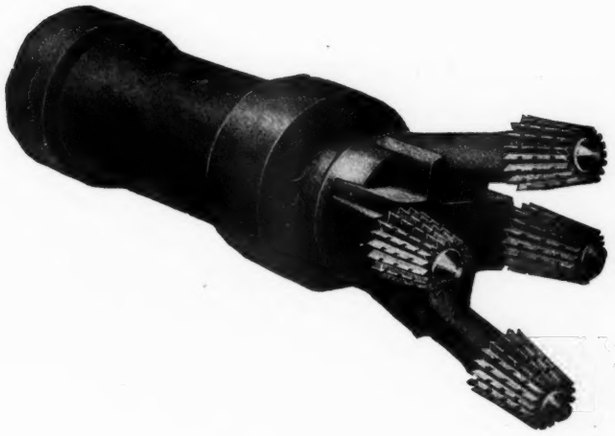
Globe Valve

Working Pressure
350 pounds per square inch

NELSON VALVE CO.

Chestnut Hill, Philadelphia

NEW YORK—90 West Street
PITTSBURGH—Jenkins Arcade
BOSTON—141 Milk Street
DETROIT—76 Larned St., West
SAN FRANCISCO—Hearst Bldg.
CHICAGO—61 West Lake Street
CLEVELAND—Rockefeller Bldg.
NEW ORLEANS—847 Baronne St.
MINNEAPOLIS—Andrus Bldg.
LOS ANGELES—310 Hibernian Bldg.
BUFFALO—982 Ellicott Square
SYRACUSE—504 City Bank Bldg.



"You know me, Al"

"Or at least you should.

"I am VICTOR, the boiler tube cleaner who won his spurs and his name right on the job in the thick of the fight.

"I am the speediest and most efficient disorganizer of scale you could wish for. I operate on steam or compressed air through 3½-in. or 4-in. straight tubes or curved tubes in the smaller sizes.

"My name and pedigree may be found in the 'Tube Cleaner Blue Book of America'—otherwise known as Catalog Z. Just ask the undersigned for a copy.

"Boiler scale is costly to keep. Don't tolerate it. My cooperation is yours to command!"

"Clean tubes pay dividends!"

Liberty Manufacturing Co.
435 Grant Street, Pittsburgh, Pa.

From Midget to Mammoth

No matter how severe the lubricating requirements of your plant may be, you can re-use the same oil over and over again, with absolute safety and a big saving in your present oil consumption, if you install R-P Oil Filters.

R-P Oil Filters are made in any capacity from 1 to 25,000 gallons per hour. They are used to purify oil collected from various machines about a plant, automatic oil circulating and filtering systems for reciprocating engines, steam turbines, hydro-electric plants; in fact, wherever oil is used there should be an R-P Oil Filter.

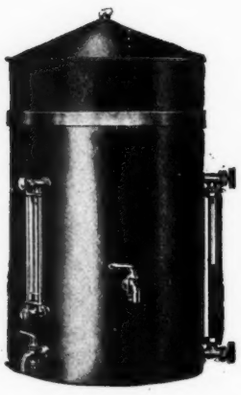
There has never been a lubrication problem put up to us that we have not successfully solved. What's yours?

Send for Book M5A, describing R-P Oil Filters. It is full of lubrication engineering data every engineer should know. It is free. Write for a copy today.

THE RICHARDSON-PHENIX CO.
LUBRICATION ENGINEERS AND MANUFACTURERS
WORKS-124 RESERVOIR AVE., MILWAUKEE, WIS.

R-P Type AP Oil Filter. Capacity 500-1000 gallons per hour.

R
OIL FILTERS
P
SCIENTIFIC LUBRICATION



R-P Portable Oil Filter. Capacity 2½ gallons per hour.

Here's Record Pump Valve Service

Two Years Service with NoKut Pump Valves.
Three Days Longest with Others—working conditions same for all valves.
Place: A Wisconsin rubber works.
Conditions: 900 lb. pressure, fluctuating speed, 24 hour-day service.

NoKut Valve Seats and Discs Absolutely Perfect After Two Years' Continuous Operation.

Before putting NoKut Valves in this pump the engineers had to renew valve discs every Wednesday and Sunday and sometimes nights between. NoKut Valves were put in, and with severe, continuous service, day and night, the engineers did not have the valve chamber open for inspection or repairs IN TWO YEARS!

Study the construction. A glance tells an engineer why they last.

The valve has beveled metal to metal seat like the seat of a safety valve. Two rubber sealing rings, shown by the arrows, are used—the greater the pressure the harder they are forced against the seats. The flow of water is nearly straight through the valve—no right—angle turn or turning of the water in an absolutely reverse direction as in a Pelton waterwheel bucket and some pump valves. The passage is freer than the steam passage in a safety valve.

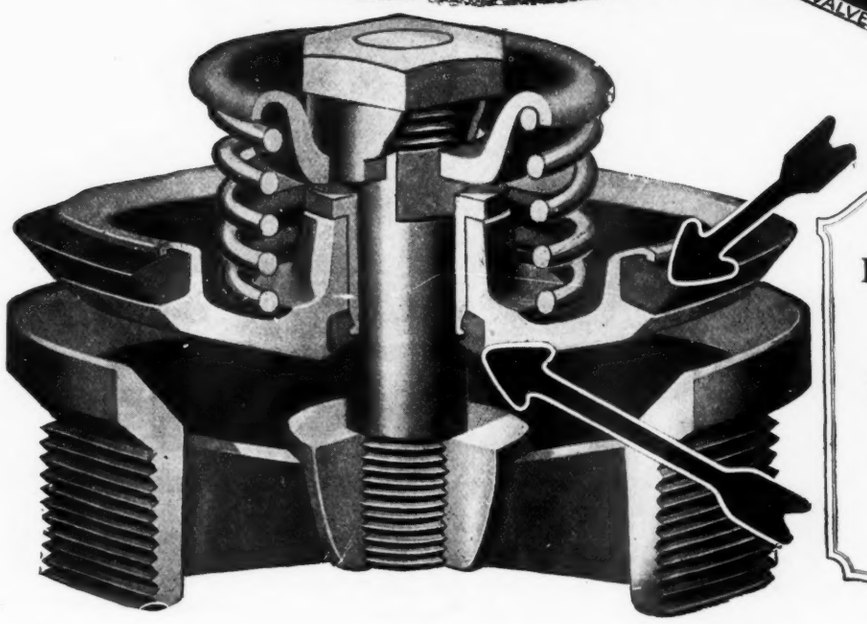
The lift is very low, inertia minimum, the port opening great, therefore no hammering action. Warping is impossible.

The Most Durable Pump Valve Made.

Send for descriptive booklet today.

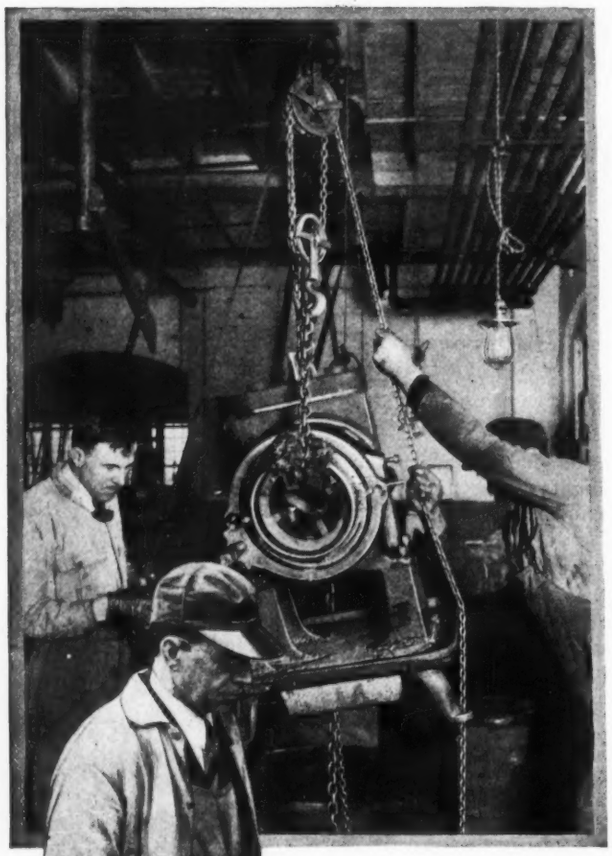
THE RICHARDSON-PHENIX CO.
MANUFACTURERS OF HIGH GRADE VALVES
WORKS 124 RESERVOIR AVE., MILWAUKEE, WIS. U.S.A.

R NoKut PUMP VALVES P
THE VALVE WITH THE PROTECTED SEAT



R P PRODUCTS

Central Oiling & Filtering Systems
Power Plant Oil Filters
Force Feed Lubricators
Sight Feed Oilers
Oil Pumps
Continuous Oiling Systems
NoKut Brass Valves
NoKut Pump Valves



That's right! Put it on the bench

Belted to your power, and set on the bench, a FORBES' (No, 98-A) PIPE THREADING AND CUTTING MACHINE will do the work of two to six men. It is "small for its size," and uses very little power compared to the work it does. Any pipe from 1 in. to 8 in. R/M. can be cut and threaded by one man, at high speed.

This all-round efficiency is gained through its plan and construction. A FORBES' revolves the die head and carries the dies and cutter *around* the pipe. The pipe is held fast in a self-centering vise at the back, and does not move.

Results? Clean, accurate threads—high speed—little power needed. One man operation and control. Bends, crooked pipe, and assembled pieces cut and threaded as easily as straight pipe. Compact size, easily transportable. Hand operation, when power is shut off.

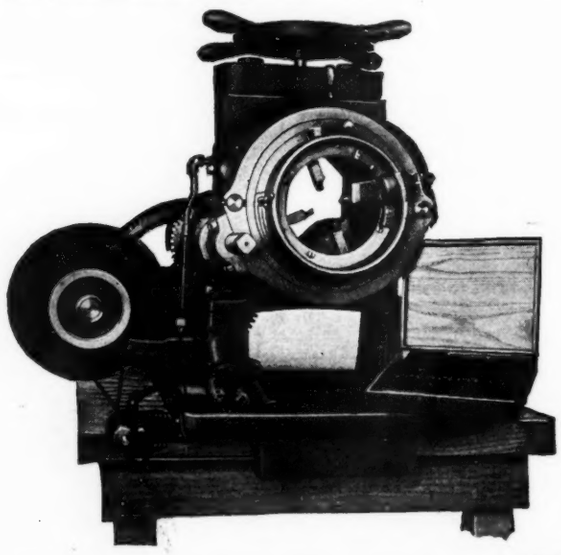
Write Curtis & Curtis for more complete information. Tell them the range of pipe sizes you use—the power available. They make other machines which might suit you if No. 98-A doesn't.

CURTIS and CURTIS CO.

302 GARDEN ST., BRIDGEPORT, CONN.

FOREIGN AGENCIES:

Anderson, Meyer & Co., Ltd., of China, Shanghai, China; Horne Company, Ltd., Tokyo, Japan; Aktiebolaget Sigfr. Anderson & Co., Malmo, Goteborg, Scandinavia and Stockholm, Sweden.



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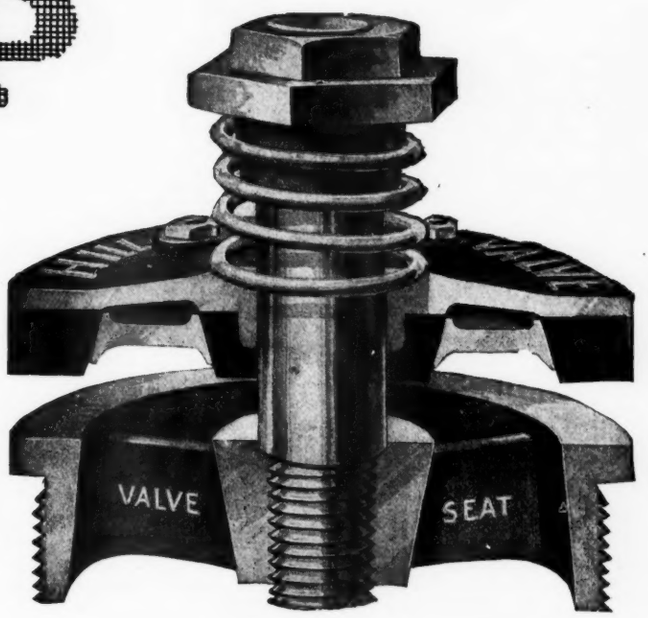
FORBES'

IT THREADS PIPE ACCURATELY

HILL PUMP VALVES



insure Continuity *of* Service

A pump that has to be taken out of service at frequent intervals for valve repairs or replacements is a needless waste.

Continuous satisfactory service without continuous maintenance attention is a certainty with Hill Pump Valves. Their ability to deliver consistently high grade service month after month has been demonstrated in over 40,000 plants.

The value of real pump valve service can be demonstrated in your own plant without cost. Just send in the necessary information on the coupon, and a set of Hill Pump Valves will be sent for 60 days' *free* trial.

On the market for over 11 *years. Installed by more than* 26,000 *companies with a total of between* 40,000 *and* 50,000 ***plants.*** *Beware of fraudulent imitations.*

Hill Pump Valve Company
Belmont and Knox Aves.
Chicago, Ill.

Branch Offices:
New York City, 242 Lafayette St. San Francisco, 616 Mission St. Atlanta, 701 Chandler Bldg.. Philadelphia, The Bourse. Buffalo, 752 Ellicott Square. Indianapolis, 222 Hume-Mansur Bldg. El Paso, 300 Herald Bldg. Pittsburgh, 2 Ross St. Detroit, 1780 Petoskey Ave. Cleveland, 1424 Rockefeller Bldg. New Orleans, 711 Hennen Bldg. Boston, 170 Summer St. Kansas City, 5511 Forest Ave. St. Louis, Pontiac Bldg. Salt Lake City, 314 Dooly Block.

Hill Pump Valve Co., Chicago, Ill.
We wish to take advantage of your offer to furnish a set of Hill Pump Valves for 60 days' trial free of charge. The following facts are for your information. Sample seat being sent via.....

No. of Valves	Tem. Water	Pressure	Name of Pump	Size of Pump	Pump No.

Seat is (pressed) (threaded) and has.....threads per inch. Face of seat is.....inches in diam.

Engineer's Name.....**Company**

Full Address.....

CAPA

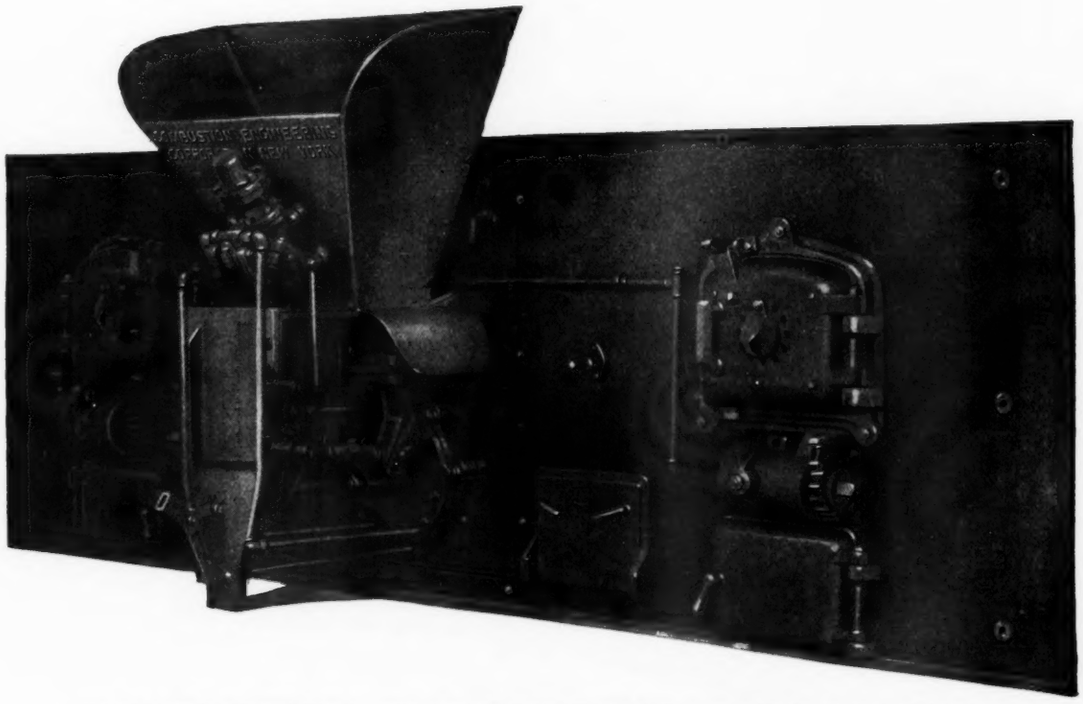
The switching engine is made to stand hard service—to haul a light or heavy load—but its chief function is to keep moving.

Economy
Capacity ✓
Simplicity
Ease of Operation
Ease of Installation

CITY

TYPE E STOKERS

Are designed for hard service to handle heavy overloads and always keep going with any kind of soft coal.



COMBUSTION ENGINEERING CORPORATION

11 Broadway, New York City

Owners and Manufacturers of

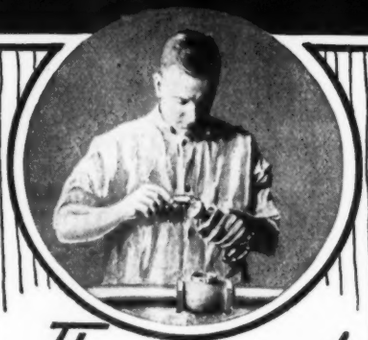
Type E Stokers—for Bituminous Coal | Lopulco Pulverized Fuel Systems | The Grieve Grate—Hand-Firing

Coxe Stokers—Anthracite Coal and Coke Breeze

PHILADELPHIA, PA. PITTSBURGH, PA. MINNEAPOLIS, MINN. BIRMINGHAM, ALA.
HAZLETON, PA. BOSTON, MASS. CHICAGO, ILL. SALT LAKE CITY, UTAH ALBANY, N. Y.
DETROIT, MICH. OMAHA, NEB. DENVER, COLO. MILWAUKEE, WIS. ATLANTA, GA.
TAYLOR ENGINEERING CO., VANCOUVER, B. C.

Superiority—unfailing

AMERICA'S BEST
LUNKENHEIMER
QUALITY
SINCE 1862



The original Regrinding Valve

performance
—service

LUNKENHEIMER REGRINDING VALVES

have firmly established their unparalleled merit by the successful results they have given through many years of satisfactory service.

The metal to metal seat—ground to a tight fit—forms the ideal seating surface to resist the wearing action of steam at high velocity. And the fact that the seating surfaces can be reground (an inexpensive operation easily accomplished) makes the renewal of parts wholly unnecessary.

Their extreme durability—due to correctly proportioned parts, high quality materials and expert workmanship—insures economy in maintenance.

Globe, Angle and Cross Valves with Inside Screw and with Outside Screw and Yoke; and Horizontal, Angle, Vertical and Swing Check Valves for 200 and 300 Pounds working steam pressure.

Specify Lunkenheimer and insist on their installation. Distributors of Lunkenheimer Products situated in every commercial center.

Write for descriptive Booklet No. 517-DB.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World
CINCINNATI

New York Chicago Boston London

3-21-42

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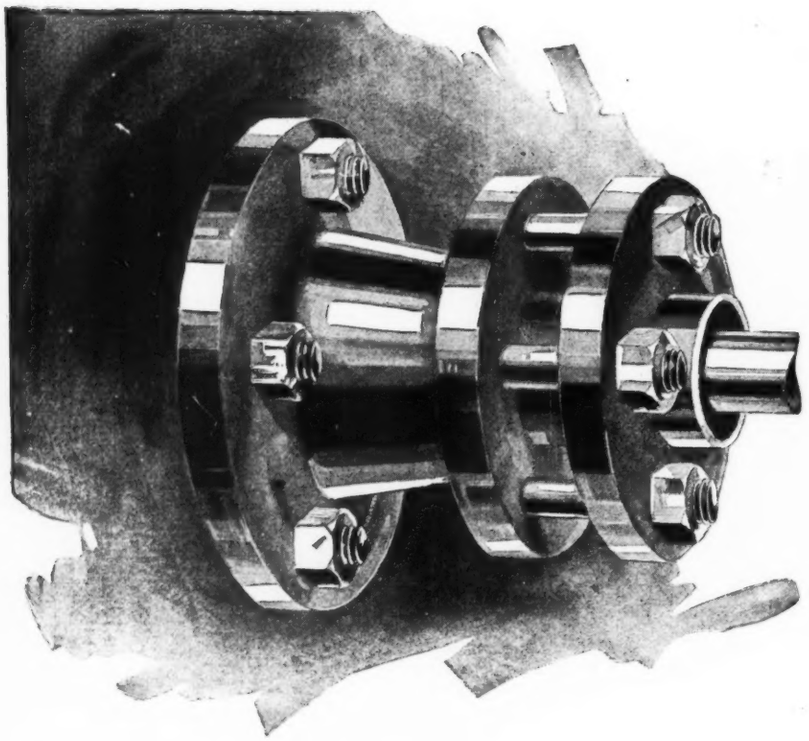


Want to cut the cost of packing rods and plungers? Read how.

Stuffing Box or Packing Retainer?

Why should most rod packing waste power?

THERE is a big difference between a stuffing box and a packing retainer, although common opinion may be to the contrary.

The difference is not in the device that holds the packing—usually termed a "Stuffing Box."

What you put into this device determines whether or not it is properly termed "Stuffing Box" or "Packing Retainer."

The reason that the question of "stuffing box" or "packing retainer" is well worth considering is because the cost of your power depends upon which are used in your plant or factory.

No device was ever better named than a stuffing box, because it is something in which material called packing is actually stuffed in a order to prevent leakage.

The Stuffing Box

The word "stuffing" generally signifies pressure, and so its use is proper in this case, not only because the packing is stuffed or pressed into the box, but because even if the gland is not screwed down tightly on the packing, the packing becomes compressed and is exerting pressure in every direction, because it expands under the action of heat or swells when saturated with a liquid. Ordinary packing in a stuffing box on account of this expansion is continually pressing against or gripping the rod, as well as the various parts of the container.

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - POWER PLANT

It is this pressure against the rod that prevents leakage, and so it must be great enough to prevent the maximum tendency of leakage. Furthermore, the pressure is constant—continuing at all times.

And so we say the term "stuffing box" is well deserved.

The Packing Retainer

If you place packing in a box and the packing is actually clear or free of the rod on account of its inside diameter being a little greater than that of the rod; if that packing was so designed that the action of temperature would not expand in against the rod and the action of the liquids would not swell and force it against the rod; and if the duty of the gland were only to hold the packing in the box, rather than to force it against the rod—does not the device or box that holds such packing in place deserve a better name than "stuffing box."

We believe it does. It is simply a holder, or "packing retainer."

The Difference

The packing in the stuffing box is forcing itself against or gripping the rod all the time. As a matter of fact it acts like and actually is a brake on the rod. Operating a pump, engine, compressor or other machine with this brake in continual operation is exactly analogous to driving an automobile with the emergency brake partially set. You rightfully think that the man who drives a car with the brake on is forgetful to say the least. He gets less power, less speed and consumes more gasoline—fuel.

So much for packing in the stuffing box.

The packing which goes into the packing retainer is free and clear of the rod and is exerting no pressure against it, but is so designed and constructed that when there is a tendency of leakage or a pressure through it a part of it *automatically* is pressed against the rod, thus preventing leakage.

It is the tendency of leakage or pressure through the box that forces the packing against the rod and so the grip on the rod is entirely proportionate to tendency of leakage, only maximum when necessary and this maximum is always the minimum required.

In other words brakes are applied only as necessary. Just as the automobile brake would be applied when driving down a steep hill

Which are you for?

If you apply this line of reasoning to your pumps, engines and various power machinery, aren't you in favor of the "packing retainer" and operating with "brakes off," rather than the "stuffing box," which necessitates "brakes on."

"Brakes on"—all of the time, means not only a tremendous waste of power and consumption of fuel, but additional and unnecessary wear on packing, rod and machinery.

The actual cost of "brakes on" is hardly appreciated

Why not pack automatically?

Thousands of engineers have packing retainers because they pack automatically and efficiently with JOHNS-MANVILLE SEA RINGS. Sea Rings are holding back steam, air, water, chemical solutions and other fluids in thousands of plants and accomplishing their purpose with least possible friction.

How Sea Rings operate.

The cut in the lower right hand corner shows the shape and design of a Sea Ring. A hard, stiff heel on the outside; a pliable lip on the inside and a hollow space between the two to allow for expansion or swelling and to provide a surface for the pressure to force the lip against the rod when necessary.

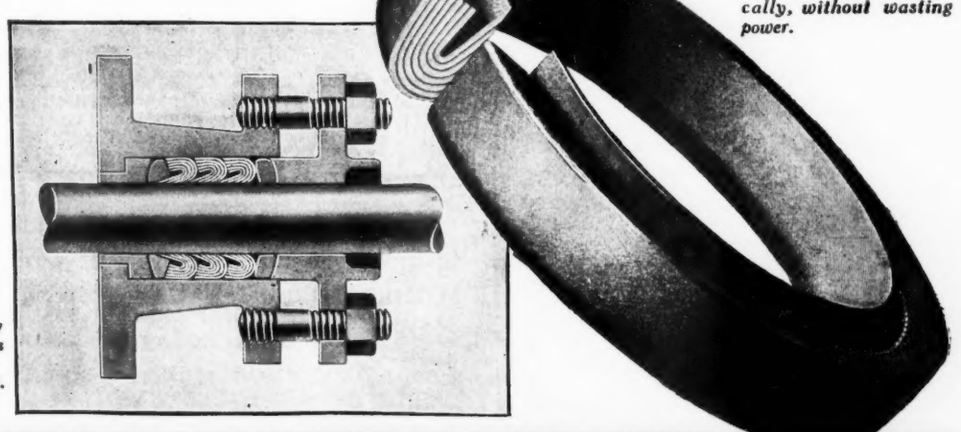
The pressure through the stuffing box and exerted on the lip, operates it. As the pressure increases or diminishes, the lips of Sea Rings hug the rod tighter or ease off accordingly.

And when there is no pressure they ease off entirely, —as on the forward stroke of an engine—during which Sea Rings are not pressing against the rod and not consuming unnecessary power.

Because both the action and pressure of the lip are automatic, both the life of the packing and the life of the rod are prolonged.

We recommend that you take off the "brakes" on your pumps and engines, save power, save packing and make your "stuffing boxes" "packing retainers."

To do this we recommend that you use Sea Rings.



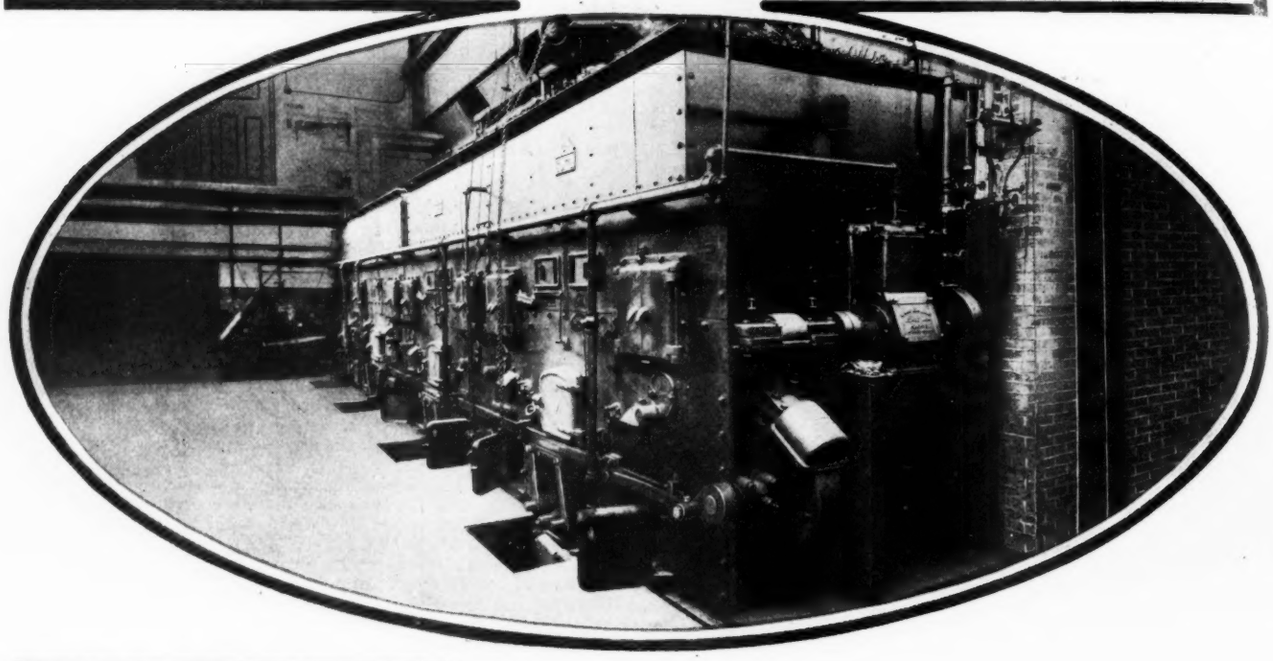
This is a Johns-Manville Sea Ring. It packs rods and plungers automatically, without wasting power.

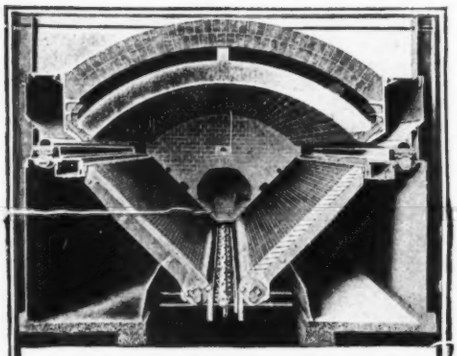
How Sea Rings look in service. A cross-section of a "packing retainer," efficiently packed.

JOHNS-MANVILLE
INCORPORATED
Madison Ave. at 41st St., New York City
10 Factories—Branches in 64 Large Cities
For Canada:
CANADIAN JOHNS-MANVILLE CO., Ltd.
Toronto

MANVILLE
MATERIALS

Economical Steam Generation





Factors Back of Every Installation of
MURPHY FURNACES

Natural Draft—on everything except the most extreme peak loads. Will double the output of your boilers without one penny for draft.

Burn any fuel. This is the biggest possible feature for the engineer to consider at the present time.

Standard—The Murphy Furnace is standard in design. All new features produced from time to time may be applied to any Murphy Furnace now in use.

Smokelessness. The Murphy Furnace is designed to afford perfect combustion. The arch insures high furnace temperature which means that the air is preheated and admitted exactly where and when needed to give maximum efficiency.

Automatic Operation. The amount of fuel supplied may be regulated while in operation. Every detail for keeping a perfect fire is provided in the design and construction of the Murphy Furnace. The coal is supplied—the fire distributed evenly—the ash removed—continuously and automatically.

The Beechnut Packing Company, known to everyone as producers of pure food products, have installed at their Rochester, N. Y., plant, four Murphy Furnaces. Two of these were put in operation in 1913 and two in 1919.

They state as their reasons for using

MURPHY AUTOMATIC FURNACES

"That economy of operation is in line with our efforts to produce high quality at lowest operating costs and general cleanliness is in keeping with our entire plant."

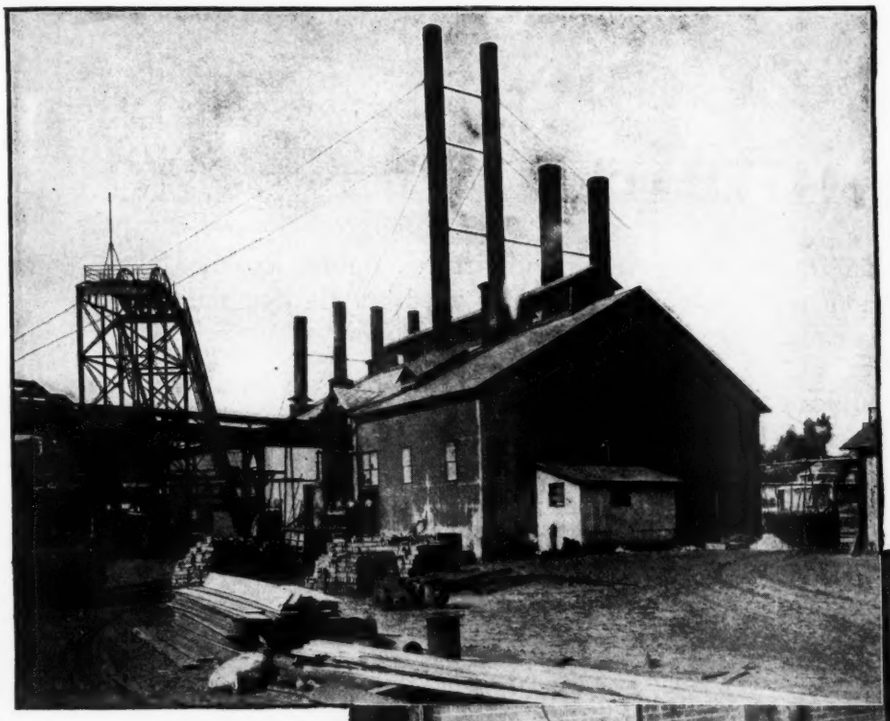
Now that low priced coal is a thing of the past, economical steam generation is being sought by every power plant manager. If you want to save from 15% to 30% of your coal bill—get rid of black smoke—solve your labor problem—or increase your boiler capacity—then you should investigate the Murphy Furnace.

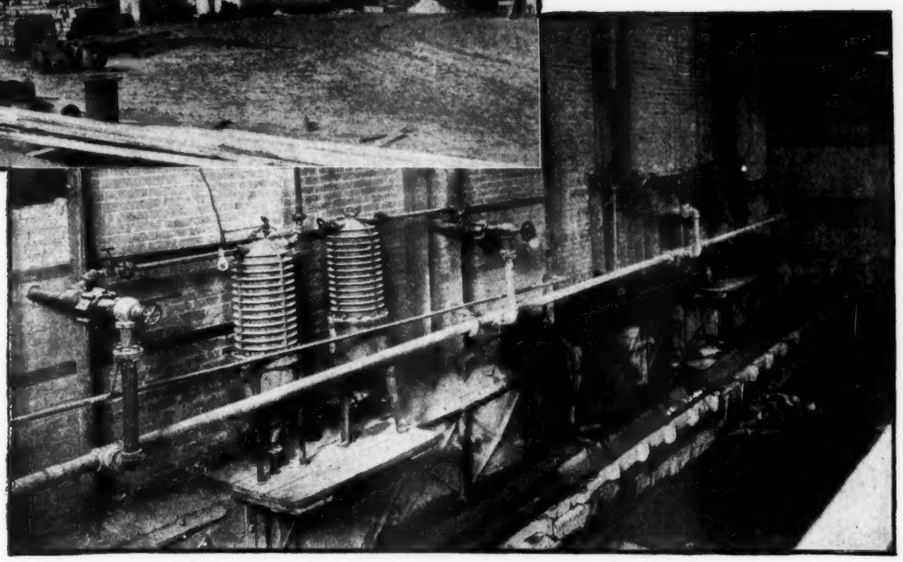
Our engineers are ready to co-operate.

Write for Catalog P-12

MURPHY IRON WORKS, Detroit, Michigan

BURN ANY FUEL THAT HAS HEAT IN IT





The Scranton Coal Co. has installed twelve YARWAY BOILER SKIMMERS, four of which are shown on the right. Their Dickson City (Pa.) colliery appears above.

YARWAY

PRODUCTS

are being used in thousands of plants. They are sold under a money-back guarantee.

Speaking of RESULTS—

The Scranton Coal Co., in a letter from its Division Superintendent, says, "Since the installation of the YARWAY SKIMMERS, a little over a year ago, we have had no further trouble with scale formation. either on shells or tubes. No trouble to wash out boilers now, as we find them clean, with no trace of scale. Requires only about one-third of the time and labor compared with our trouble when using compounds. Cannot speak too highly of the results we are getting from the Skimmers."

Bulletin S-1201-A is an interesting little booklet on water-conditioning treatments. We shall be glad to send a copy at your request.

YARWAY

BOILER SKIMMER

(A Continuous Circulating Surface Blow)

Removes scale-forming impurities and foreign matter from boiler feed-water before they can settle on shell and tubes, except in unusual cases where certain mineral salts are carried in solution. If you will advise us of your water conditions and the type of your boiler, we will tell you frankly whether or not you can use a YARWAY BOILER SKIMMER to advantage.

For complete list of offices, see Sweet's Engineering Catalog, Condensed Catalogs of A. S. M. E., Sterling Marine Catalog, Keystone Mining Catalog or Chemical Catalog.

YARNALL-WARING CO.

Mermaid Ave. Chestnut Hill

Philadelphia

Offices in all Principal Cities

How the Copes Maintained Its Lead

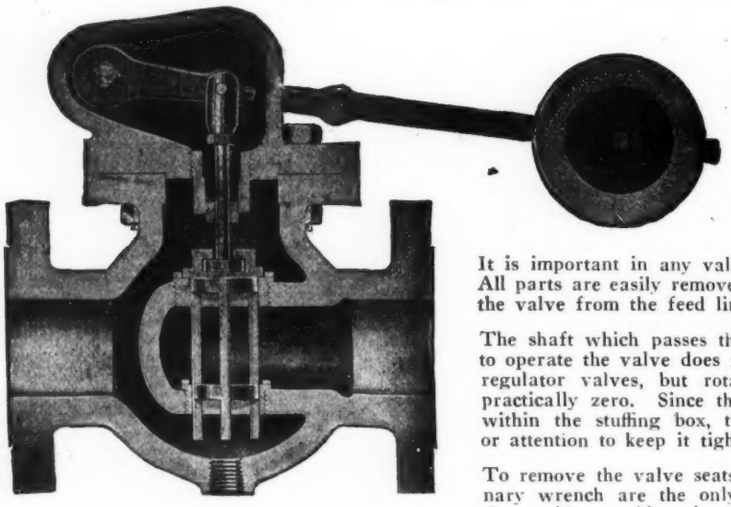
After having won its first great victory in firmly establishing the new variable water level principle of boiler feed regulation, the Northern Equipment Co. set about to solve the problem of

(1) **Making valve parts which are exposed to corrosion and wear of such material and design as to reduce the effect of these detrimental influences to a minimum.**

(2) **Making the valve seats and fittings easily replaceable.**

(3) **Reducing friction in the valve to a minimum, making it very easy to operate.**

The Copes Regulator Control Valve



This cross-sectional view shows the perfectly balanced Copes Control Valve, in which sliding spindles have been entirely eliminated.

A weight is used instead of springs, giving constant force. No rusting, no sticking, no weakening with age.

It is important in any valve that parts can be easily reached. All parts are easily removed from the Copes, without removing the valve from the feed line.

The shaft which passes through a stuffing box in the housing to operate the valve does not slide in and out like in ordinary regulator valves, but rotates with a frictional resistance of practically zero. Since the same part of the shaft is always within the stuffing box, the latter seldom requires repacking or attention to keep it tight.

To remove the valve seats, a piece of flat stock and any ordinary wrench are the only tools necessary. This too, can be done without taking the Copes valve out of the feed line.

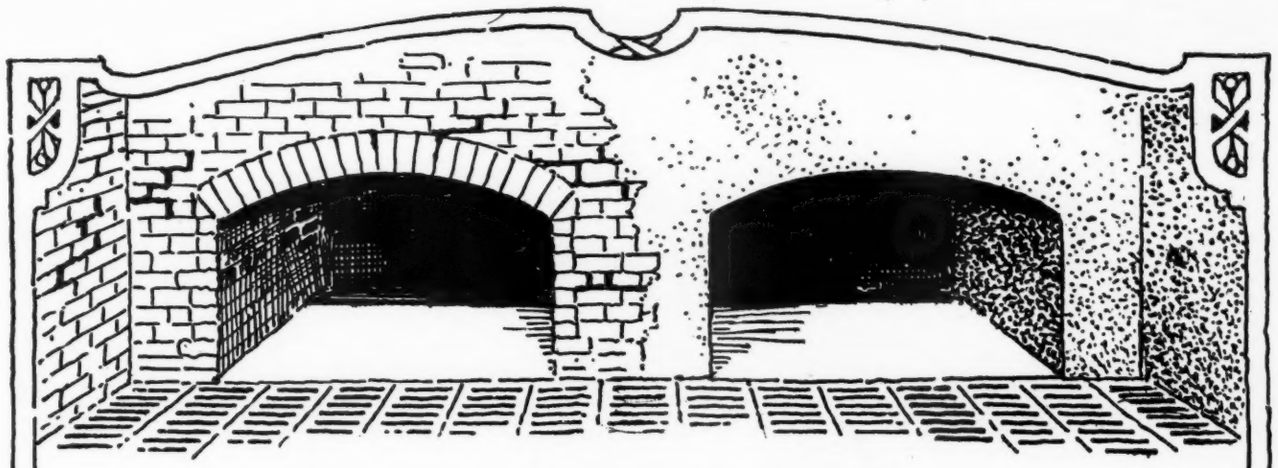
COPES

NORTHERN EQUIPMENT CO.

110 WEST 11TH STREET.——.——.ERIE, PENN.

The World's Largest Manufacturers of Feed Water Regulators

118



Tired of Re-lining?
You Know the Rest—

HOTT-PATCH
Furnace Cement

PATENTED JANUARY 13TH, 1920

"Clinkers Won't Stick"

Clinkers cannot stick on linings of Hott-Patch because the chemical composition of this cement makes it impossible—*chemically impossible*—for clinkers to form at all!

An even burning fire over the entire fuel bed is the result. There is no loss in heat output and the men do not spend valuable time digging out clinkers.

The furnace walls last much longer, with greatly reduced repair cost.

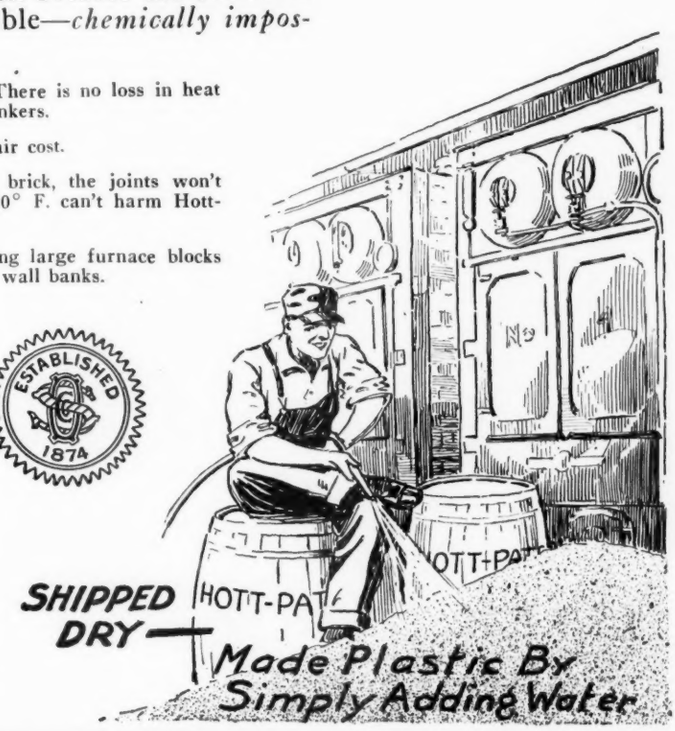
Because Hott-Patch has the same rate of expansion as fire brick, the joints won't crumble, crack or warp under heat. Temperatures up to 3000° F. can't harm Hott-Patch.

Hott-Patch is without an equal for pouring baffles and molding large furnace blocks or special shapes. Use it for front and rear arches and bridge wall banks.

EVERYTHING YOU NEED IN YOUR FOUNDRY

As an evidence of our faith in the enduring service that Hott-Patch can give your settings: We will ship a barrel or a ton of Hott-Patch on approval, with freight prepaid, east of the Mississippi and as far south as Atlanta, Ga. It must make good or you owe us nothing. May we have a line from you today?

ESTABLISHED 1874



THE S. OBERMAYER CO.

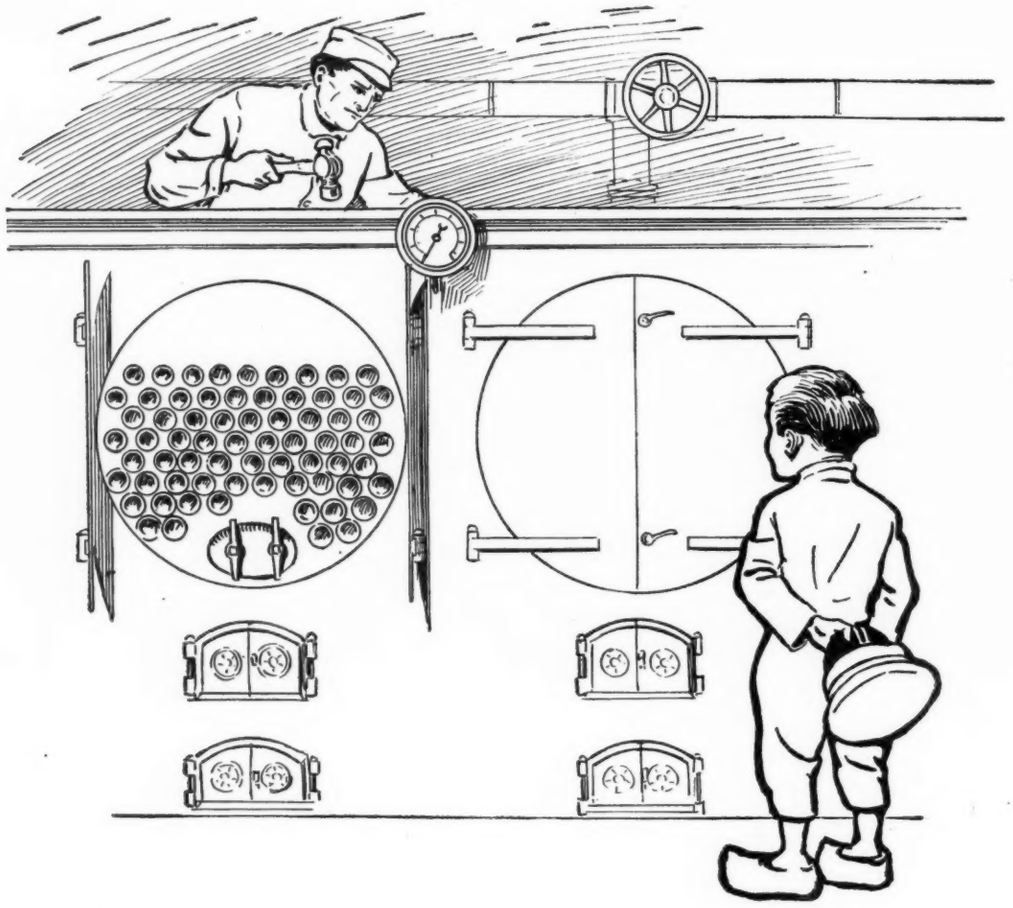
2833 Smallman St., Pittsburgh, Pa.

Baltimore Office: 2 E. Lexington St., Baltimore, Md.

Factories in Chicago, Ill.; Cincinnati, Ohio; Rillton, Pa.

We carry stocks in Pittsburgh, Pa.; Cincinnati, Ohio; Chicago, Ill.; Detroit, Mich.; Philadelphia, Pa.; Newark, N. J.; and Springfield, Mass.

New England Agents: Springfield Facing Co., Springfield, Mass.



Perolin on trial

Any power plant desiring relief from boiler troubles, due to scale, oil, pitting, or corrosion, can test the merits of PEROLIN — THE BOILER METAL TREATMENT—without risking one single penny.

Sufficient material will be sent, upon request, freight prepaid, for a full sixty days' trial in boilers of the plant. If PEROLIN—THE BOILER METAL TREATMENT—does not live up to each and every claim made for it, no payment need be made.

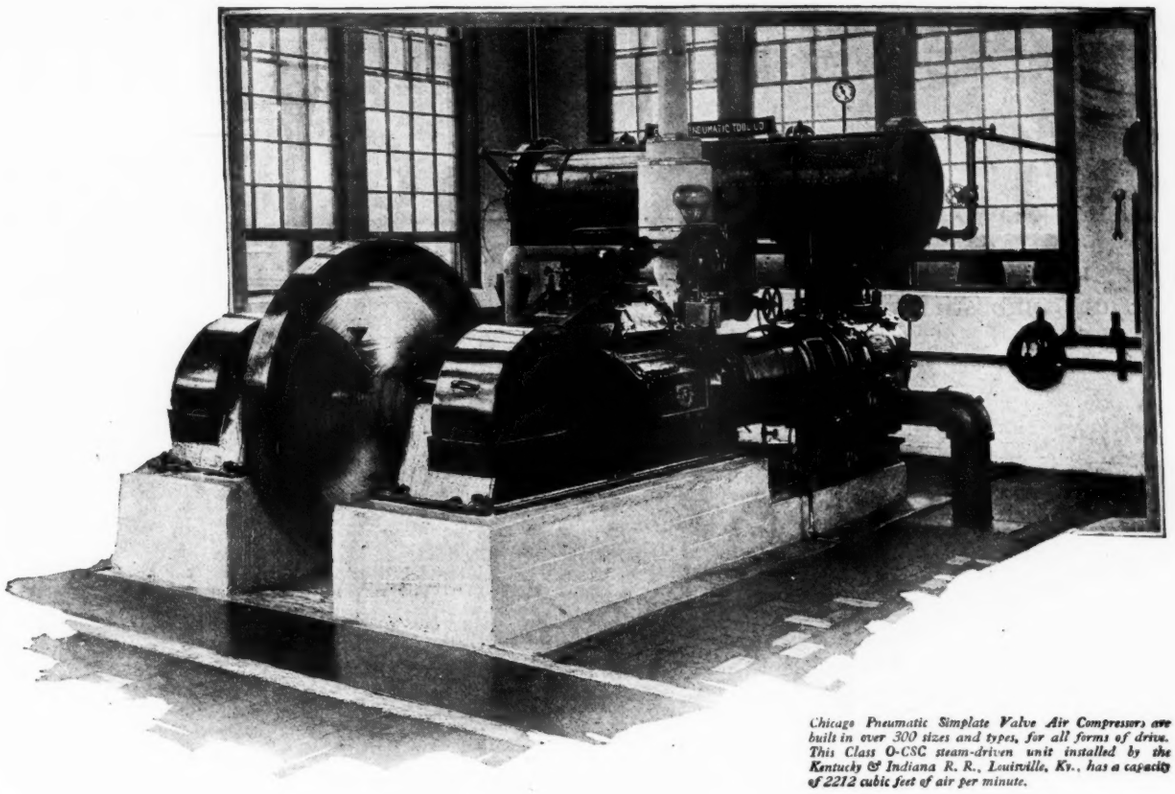
Send for booklet and free trial offer today.

The Perolin Company of America

New York Toronto London Chicago

This advertisement copyrighted, 1917. The Perolin Company of America.

Perolin
The Boiler Metal Treatment



Chicago Pneumatic Simplate Valve Air Compressors are built in over 300 sizes and types, for all forms of drive. This Class O-CSC steam-driven unit installed by the Kentucky & Indiana R. R., Louisville, Ky., has a capacity of 2212 cubic feet of air per minute.

Another way in which Chicago Pneumatics save power

FROM no-load to full-load, Chicago Pneumatic Air Compressors economize power.

Under all load conditions the cylinder ratio of stage machines is unchanged. This insures highest power economy under variable air demands.

Under no load the inlet valves are automatically held open, permitting free passage of air.

Chicago Pneumatics thus save power over those compressors using a "choked intake" with its resultant losses.

Bulletin 400 tells about this and other Chicago Pneumatic economy features. May we send your copy?

Chicago Pneumatic Tool Company

Chicago Pneumatic Building • 6 East 44th Street • New York

*Sales and *Service Branches all over the World*

*Birmingham *Boston *Buffalo *Chicago *Cincinnati *Cleveland *Detroit *El Paso *Erie *Franklin *Houston *Joplin *Los Angeles *Minneapolis *New Orleans *New York *Philadelphia *Pittsburgh *Portland *Richmond *Salt Lake City *San Francisco *Seattle *St. Louis *Barcelona *Berlin *Bombay *Brussels *Buenos Aires *Cadiz *Christiania *Fraserburgh *Havana *Honolulu *Johannesburg *Lisbon *London *Madrid *Milan *Montreal *Osaka *Paris *Seoul *Tokyo *Toronto *Vancouver *Winnipeg

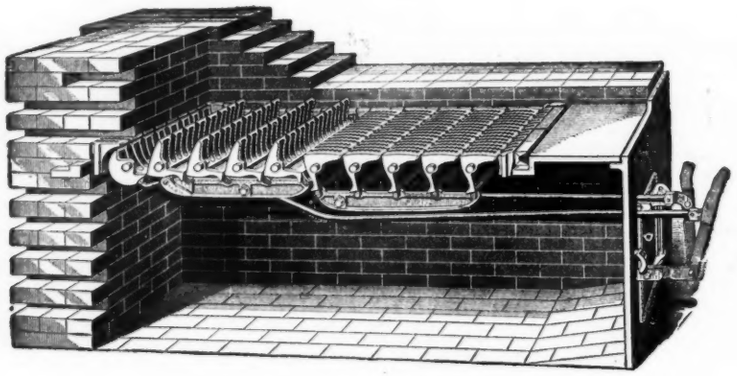
BOYER PNEUMATIC HAMMERS··LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS··VACUUM PUMPS··PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS ·· COAL DRILLS

CHICAGO PNEUMATIC

The Compressor with the Simplate Valve

Free Burning Fires With Caking Coals

It makes no difference what the quality or character of the fuel to be burned—highly efficient, smokeless combustion can always be obtained with



McClave Grates

Equipped With

Argand Blowers

A modern system of combustion developed after nearly 40 years of specialization in the field. Especially designed to burn the poor grades of anthracite screenings, mine run, culm, lignite and all caking or clinkering coals, smokelessly and with the maximum obtainable heat output.

The Argand Blower

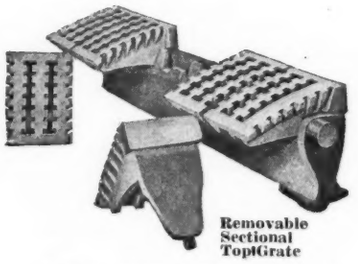
Very economical in steam consumption. Easily installed. Occupies little space. Cannot get out of order.

The entire grate is carefully designed to eliminate warping, injurious stress and burn-outs. Ample provision is made for free movement under expansion.

The removable top grates are sectionalized into standard units, which may be furnished with a great variety of different size air spacing, to adapt them to the fuel to be burned.

The cut-off and shaking movements are obtained by working outside levers. This breaks up every part of the fire and keeps it open and porous, without loss of combustible.

The combined air and steam blast of the Argand Blower is under full control of the firemen. When desired automatic control may be installed.



Removable Sectional Top Grate

Easily removed and replaced without disturbing the remainder of the grate.

McClave-Brooks Company

Main Office and Works, Scranton, Pa.

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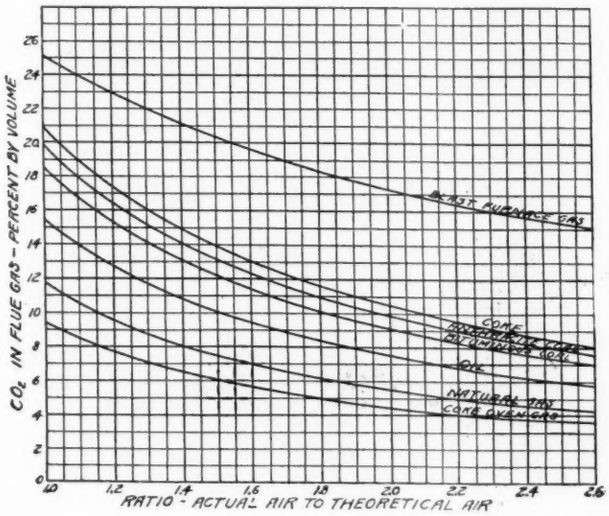
Does CO_2 Mean Anything for Calculating A Boiler Heat Balance?



The object of Flue Gas analysis is to determine the amounts of excess air and unburned gases from combustion. It requires the complete analysis including CO_2, O_2 (oxygen) and CO to obtain the desired results.

CO_2 is the gas most readily determined and many people think no further analysis need be made. In some cases it does give a dependable check on excess air, but even excess air depends a great deal upon the fuel being burned. It is noted from the diagram above that the CO_2 varies between 6.5% from By-product Coke Oven Gas and 14.8% from Coke, to as high as 21% from Blast Furnace Gas, with 40% excess air in each case. These results are therefore obtained when the actual air being used is 1.40 times the theoretical requirement.

In many steel mills, two and sometimes all three of these fuels are burned alternately or at the same time in varying proportions and it is evident that the CO_2 determination alone would give no information whatever regarding excess air. Even with coke, anthracite and bituminous coal the excess air for a given CO_2 varies from 15 to 40%, and with oil and natural gas the variations are so great that engineers are often badly misled when they try to apply the standard of one fuel to the burning of another.

The reason for the variations in the CO_2 for different fuels with the same excess air is due to the available hydrogen in the fuel combining with a portion of the 20.9% oxygen in the air. This forms water, which condenses before the gas analysis is made.

The CO_2 and O_2 do not add up to 20.9%, except in the case of coke when there is no CO. The total of these two gases varies with both the fuel and the excess air.

The calculation for excess air does not involve the percentage of CO_2 at all, but is based upon the free oxygen, which represents the air that has not been used and the nitrogen which represents the total air supplied.

$$\text{Excess Air} = \frac{100\ O_2}{.264\ N_2 - O_2}$$

$$\text{The ratio of actual air to theoretical} = \frac{N_2}{N_2 - 3.78\ O_2}$$

Assume a flue gas analysis of 13.07 CO_2; 6.2% O_2; no CO and 80.8% N_2. The excess air is 41% and the ratio of actual air to theoretical air is 1.41.

Excess air should be calculated separately for each gas analysis and the results averaged, instead of averaging the gas analysis and then calculating the excess air. For instance, the excess air calculated from another analysis of 6.0% CO_2, 14.1% O_2 and 79.9% N_2 gives 200%. The average of the two gas analyses is 9.5% CO_2, 10.15% O_2 and 80.35% N_2 and the excess air calculated from it is 92%, while the average excess air from the individual calculations is 120%. This difference corresponds to an error of about 2.5% in calculating the boiler heat balance.

The Bailey Boiler Meter measures the actural flow of excess air and products of combustion as well as the steam output and also records the flue gas temperature all on one chart. Complete calculations of chimney heat losses can be made directly from Bailey Meter Charts.

The Chart No. 4003 *being sent with this issue is from an* 824 *hp. Stirling Boiler, being fired with oil. Fill out the coupon and get these interesting charts. This heat balance discussion started in the November* 30 *issue. Look up back numbers or write us for reprints.*

Our next advertisement will give the losses calculated from charts Nos. 4003 and 4009 and will show how these results are obtained.

Bailey Meter Co.

2011 E. 46th St., Cleveland, Ohio

Bailey Meter Company,
2011 E. 46th St., Cleveland, O. **FREE**

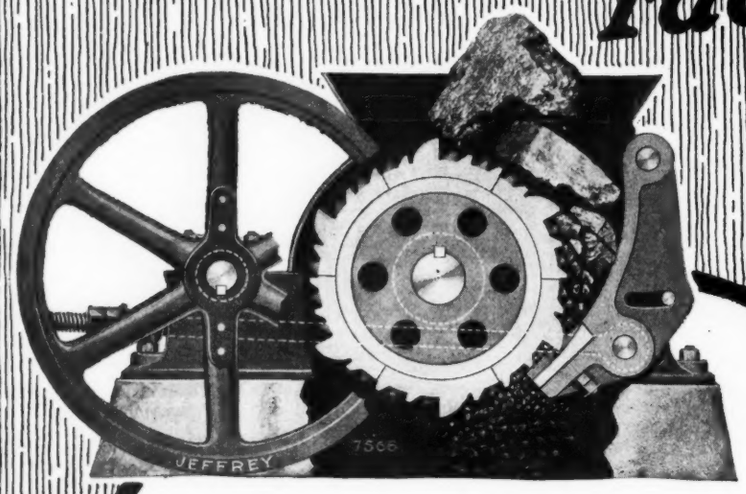
Please send chart records from meters supplementing your ads in Power beginning with December 21 issue.

Name .....

Address .....

.....

Power plant efficiency = 100% Factor of Safety = ?



Your plant may be functioning at top notch speed—there may be close co-operation, scientific management, large output, quick deliveries and everything operating at the highest efficiency. But at the very minute you may be working under a peak load, you suddenly find yourself deprived of a supply of stoker coal and your whole system goes to smash. You have overlooked the Factor of Safety.

A Jeffrey Single Roll Crusher

installed in your power plant means a real lasting and dependable Factor of Safety.

It crushes run-of-mine or lump coal to stoker size in one operation and makes your plant independent of Mine, Weather and Traffic Conditions.

Write today for copy of Bulletin No. 141-C

SHIPMENT FROM STOCK

The Jeffrey Mfg. Co.
932 North Fourth Street
Columbus, Ohio

Complete test before shipment

A feature of great importance to purchasers of

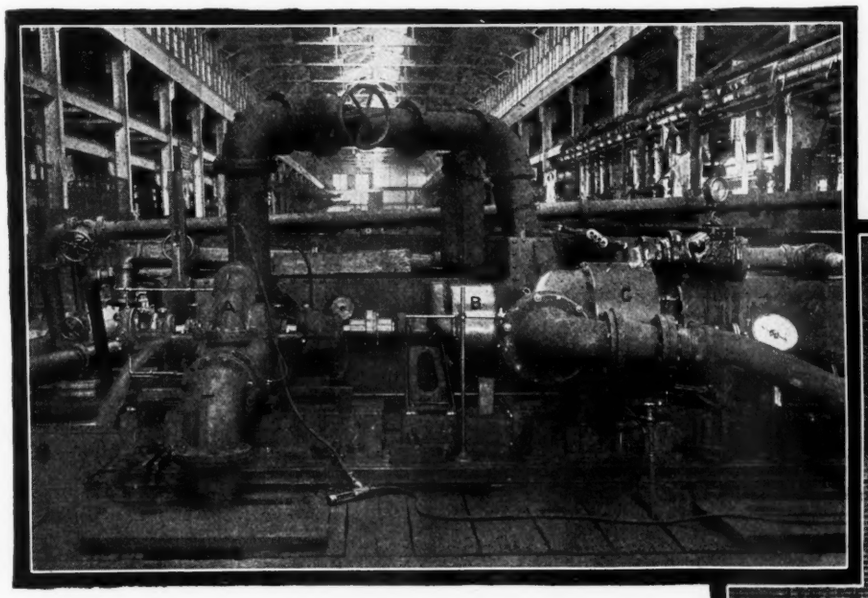
INGERSOLL-RAND

LOW LEVEL MULTI-JET CONDENSING PLANTS

is that the equipment is fully tested before leaving the factory.

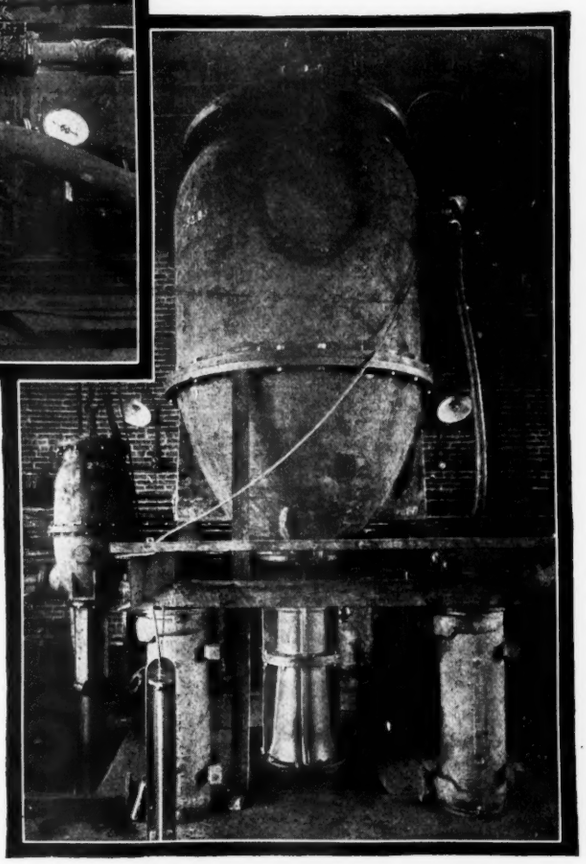
The Injection Water Pump is tested for capacity, head and power consumption. The condenser is tested for vacuum when handling the rated quantity of water. Before shipment, all condensers must show a vacuum within 0.1 of that corresponding to the temperature of the cooling water, without steam load.

Combined with the simplicity and efficiency of the Ingersoll-Rand Low Level Multi-Jet Condensing Plant is this positive proof of its performance.



Cameron Centrifugal Pumps under test at the A. S. Cameron Steam Pump Works. All pumps are given Complete Performance Test. Water is measured by Weirs and power by Torsion Dynamometers (B)

Complete information on request



Two Multi-Jet Condensers, one small and one large, on Test; all Multi-Jet Condensers are Tested at the factory, and must show a vacuum within 1 in. of that corresponding to the water temperature when operating without steam load. Customers are invited to inspect condensers while under test.

INGERSOLL-RAND COMPANY

11 Broadway, New York

Detroit, Mich.	Knoxville, Tenn.	Philadelphia, Pa.
Joplin, Mo.	Houghton, Mich.	Denver, Colo.
San Francisco, Cal.	Cleveland, Ohio	Boston, Mass.
Salt Lake City, Utah	Pittsburgh, Pa.	El Paso, Texas
Havana, Cuba	Birmingham, Ala.	Dallas, Texas
Butte, Mont.	Los Angeles, Cal.	Seattle, Wash.
Juneau, Alaska	New Orleans, La.	St. Louis, Mo.
Duluth, Minn.		Chicago, Ill.
New York, N. Y.		Scranton, Pa.

Ingersoll-Rand

Oil Engines **Cameron Pumps** **Air Compressors**

3-L.L.J

Full Area Opening

Here is another important advantage of Homestead Quarter Turn Valves. There is no appreciable resistance to the flow—the full pipe area is available, without pockets or projections to cause wasteful eddies or friction.

When the Homestead is closed it is positively tight, because the plug is automatically forced downward in closing by a patented floating cam that locks it tightly in place.

A quarter turn of the handle either opens or closes the valves completely.

Made for steam, water, acid, oil, gasoline, gas, air, and superheated steam and any heavy or gritty liquid, screwed or flanged in straightway, three-way, four-way or angle pattern for pressure up to 5000 lbs.

Install a "Homestead" in place of a globe or gate valve on the identical service and watch the results

Homestead Valve Mfg. Co.
134 6th Ave., Homestead, Pa.
New York Office: 242 Lafayette St.

HOMESTEAD
QUARTER TURN VALVES

DURABLA

Trade Mark Reg.—U. S. Pat. Office

STRENGTH—GOODNESS—QUALITY

Etched on Every Glass

TESTS OF HIGH PRESSURE GAUGE GLASS

Temperature	Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.
Erosion	No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.
Tensile Strength	Remained unbroken under hydraulic pressure of over 2000 pounds per square inch for 2 minutes.
Service	Under continuous operating conditions with pressure of 225 pounds, performance equaled in every respect the best service ever obtained by any foreign glass.

DURABLA U. S. A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

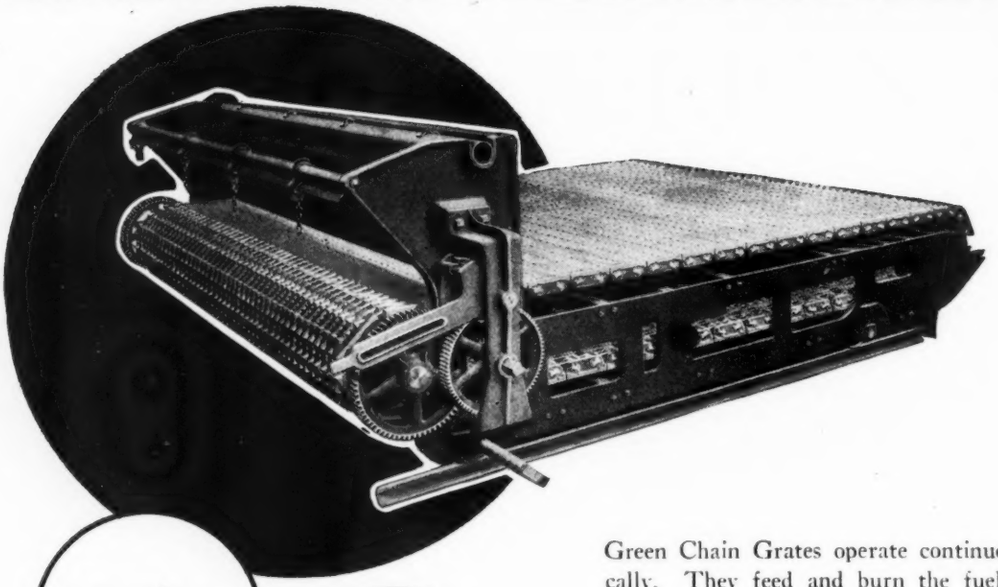
MADE IN U. S. A.

DURABLA MANUFACTURING CO.

New York Chicago Pittsburgh Philadelphia Dallas San Francisco

DURABLA

Money Saving is a Green Chain Grate Characteristic



operates automatically

without clinkers

Maintains Overloads

Saves Fuel and Labor

Green Chain Grates operate continuously and automatically. They feed and burn the fuel, discharge the ash and clean the grate surfaces without human assistance.

The fuel bed remains undisturbed at all times and since the ash is isolated from the high temperature of the furnace it cannot fuse into clinker.

Overloads are maintained indefinitely because there are no shutdowns to clean fires or to prepare for peak loads. Capacity in the Green sense is *continuous* capacity.

Substantial savings in fuel are assured in Green equipped plants, because with the Green Chain Grate the poorest coals on the local market can be burned with high efficiency.

The relation of proper coal burning and efficient stoker firing to the cost of producing power is clearly outlined in the Green Book. Write to Department A for your copy.

Green Engineering Company
40 Kennedy Ave., East Chicago, Indiana

Backed by 23 Years of Specialized Experience

GREEN Sealflex Arches
GREEN Pressure Waterbacks
GREEN Steam Jet Ash Conveyor
GREEN Cast Iron Ash Tanks

GREEN CHAIN GRATES

B-G STANDARDIZED CONVEYORS

B STANDARDIZED MATERIAL-HANDLING MACHINES G
AURORA ILLINOIS

Now as never before, all users of large quantities of coal realize the absolute necessity of storing coal and of handling—storing and reclaiming—by machinery.

The superiority of B-G machines for short-haul, loading and unloading problems is beyond question.

In Every Power Plant

B-G equipment has its place. B-G Conveyors for unloading cars and moving to storage piles. B-G loaders to reclaim from storage, loading wagons, wheelbarrows, cars or conveyors.

Hundreds of the biggest plants, both here and abroad, find them profitable—even a necessity. How about your plant?

B-G engineers are at your disposal to make suggestions and to work with you on the selection of equipment. This service is free. Tell us your problems.

Catalog R, just off the press, will be sent to those who can use it. It contains many installation photographs and stories of what B-G machines are doing. Have you your copy?

Barber-Greene Company

Aurora, Ill., U. S. A.

ALMACOA EXPORT DEPARTMENT ALLIED MACHINERY COMPANY OF AMERICA ALMACOA

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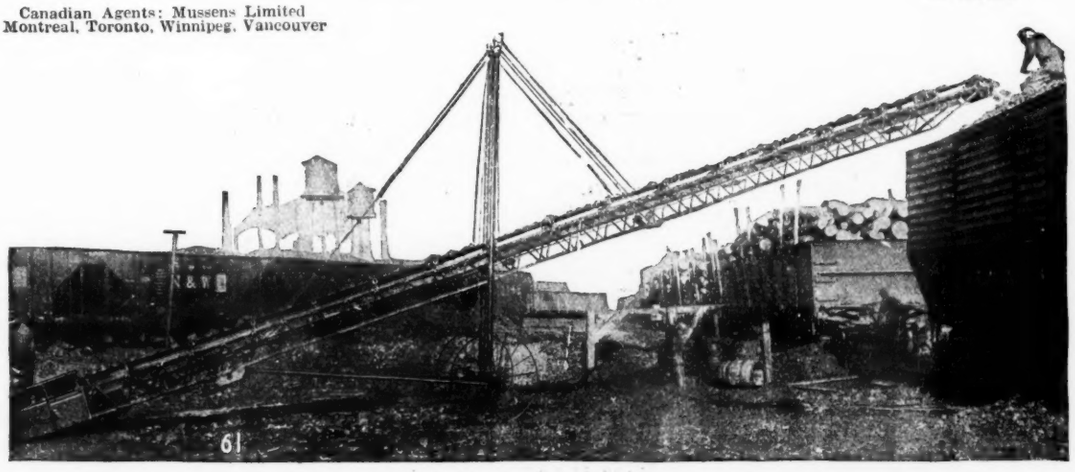
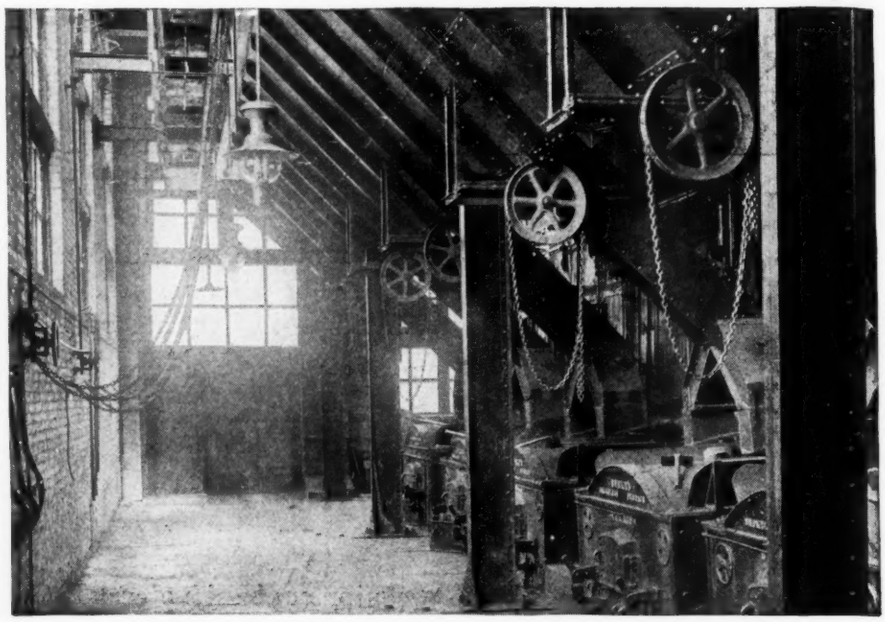


Type of Rex Chabelco Steel Roller Chain used for carrying the buckets of Rex Coal and Ash Handling Systems.



Boiler Room of Mayer Boot & Shoe Company where Rex Coal and Ash Conveyor is saving 15 man-hours a day

Cleaning Up the Boiler Room

Apart from the decisive savings they effect in the cost of labor Rex Coal and Ash Handling Systems help make the boiler room a cleaner, better place to work in.

They do away with the drudgery and disorder which inevitably attend the handling and re-handling with shovel, wheelbarrows, trucks, and cans.

They help invite and retain a better class of men, promote greater boiler room efficiency, and assist vitally in guaranteeing continuous, low-cost power plant operations.

If you are still using old-fashioned and expensive handling methods have one of our engineers study your boiler room conditions and point out the specific benefits of a Rex Coal and Ash Handling System.

REX CHAIN

Rex Traveling Water Screens, Rex Concrete Mixers and Pavers, Rex Sprockets, Rex Elevators and Conveyors

Bucket conveyor of the Rex Coal Handling System dumping coal into overhead hoppers at the plant of the Mayer Boot & Shoe Company

And Saving $2250 a Year

Until 1914 the Mayer Boot & Shoe Company of Milwaukee, with 500 boiler h.p., had coal wheeled into the boiler room with small carts and dumped on the floor. The manual handling of ashes made this practice increasingly disagreeable and costly.

After a thorough study of the plant lay-out and operating conditions a Rex Coal and Ash Handling System, used with overhead storage hoppers, was installed.

Now one man per shift not only does the work which formerly required two men but does it with much less effort. Through the Rex Conveyor System the Company figures a saving of at least 15 man-hours a day, which, at the rate of 50 cents an hour for 300 days, totals $2250 a year.

Rex Coal and Ash Handling Systems, built with Rex Chain, are showing similar economies in scores of other plants throughout the land. They can do the same for you.

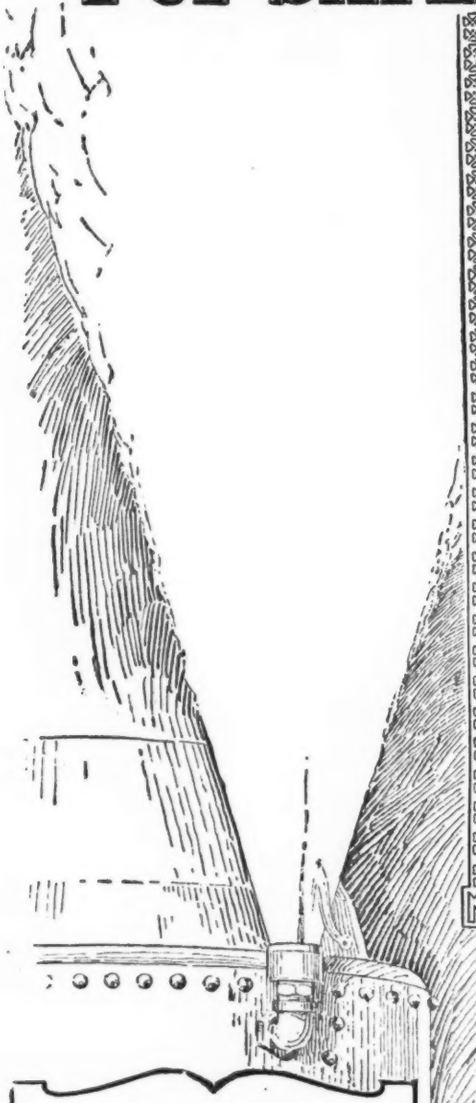
You can secure standard Sprocket Chain of any size or type, either through distributors or direct, for every transmission and conveyor need.

REX CHAIN

CHAIN BELT COMPANY, MILWAUKEE

Branch Offices and Representatives in Principal Cities in the United States and Abroad

CONSOLIDATED POP SAFETY VALVES



Guardians against over pressure

After the blow-up it's too late to think of them—the most inexpensive insurance you can get against disaster—whether

—compared to the price of the boiler,

—to the time lost by the shut down,

—to the value of the lives which they will safeguard,

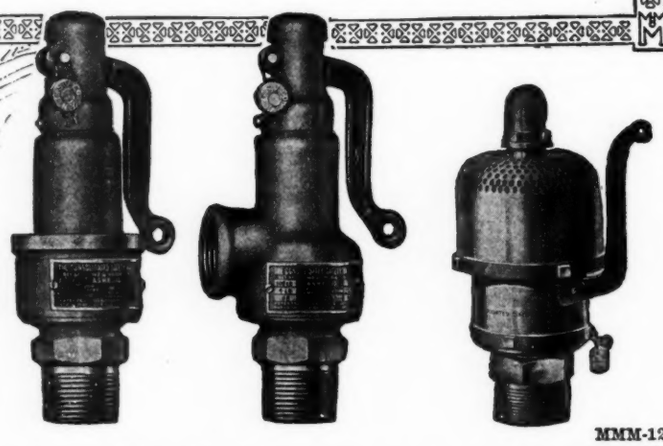
—or the cost of the property they will protect.

Insist upon *Consolidateds*

—you will get unfailing action at the moment the set pressure is reached and

—unfailing *relief* of the boiler.

Your jobber stocks them because he knows they mean the safest form of boiler insurance.



MMM-122

Consolidated For Portable Boilers

Performs Better than A.S. M.E. Requirements.

Made in three types.

Form H with top outlet.

Form I with side outlet.

Form K with muffler.

In sizes from ½ in. to 3 in.

Set at all standard pressures.

The plate on each valve gives the information necessary to select the right valve.

86

CONSOLIDATED SAFETY VALVE CO.,
SALES DEPARTMENT OF
MANNING, MAXWELL AND MOORE, INC.
119 West 40th St. NEW YORK 29 North Jefferson St., CHICAGO
Consolidated Safety Valves, Hancock Inspirators, Hancock Valves, Metropolitan Injectors

HANCOCK VALVES

The Companions of Superheat & High Pressure

Did You?

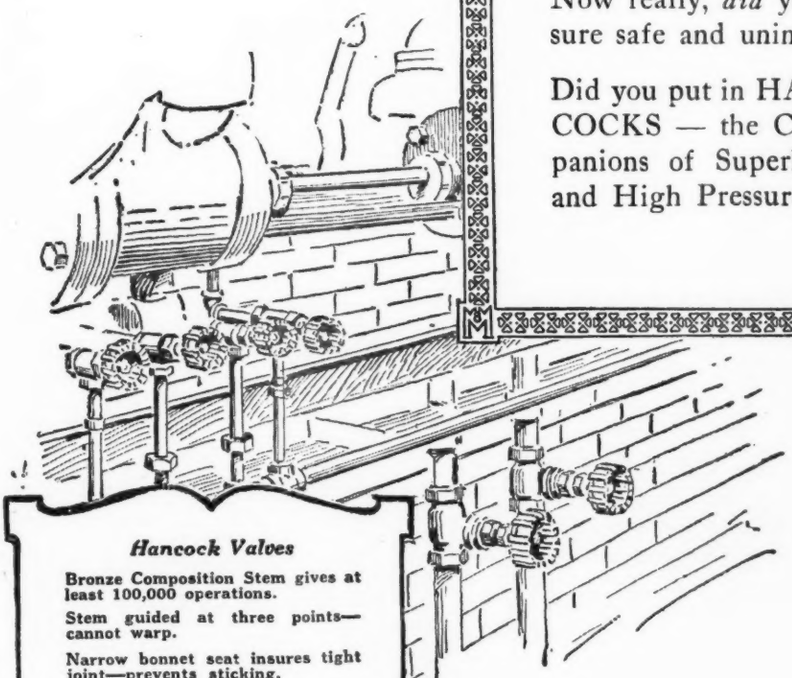
Sizz!! A sudden rush of hot, scalding steam, and the dreaded has happened—a valve has given way on the high pressure line,

—and the plant was working overtime to keep up with its production schedule,

—and now, lost time, enforced idleness and lost production, while you make that repair. True, only the other Sunday you put the valve in because the old one was leaking badly; you did all you could to make sure the plant would keep going.

Now really, *did* you do all you could to insure safe and uninterrupted operation?

Did you put in HANCOCKS — the Companions of Superheat and High Pressures?



Hancock Valves

Bronze Composition Stem gives at least 100,000 operations.

Stem guided at three points—cannot warp.

Narrow bonnet seat insures tight joint—prevents sticking.

Disc cannot become cocked.

Renewable disc and seat of special bronze or nickel according to use.

Packed without shutting off steam, even with high pressure superheat.

Projecting lip on disc cleans seat just before closing valve.

Cylindrical form of body enlarges steam areas, reducing friction.

Bronze body valves guaranteed up to 500 degrees. Steel body valves for higher temperatures.

82

MMM-109

The HANCOCK INSPIRATOR COMPANY
SALES DEPARTMENT OF
MANNING, MAXWELL AND MOORE, INC.
119 West 40th St. NEW YORK 29 North Jefferson St. CHICAGO
Consolidated Safety Valves, Hancock Inspirators, Hancock Valves, Metropolitan Injectors

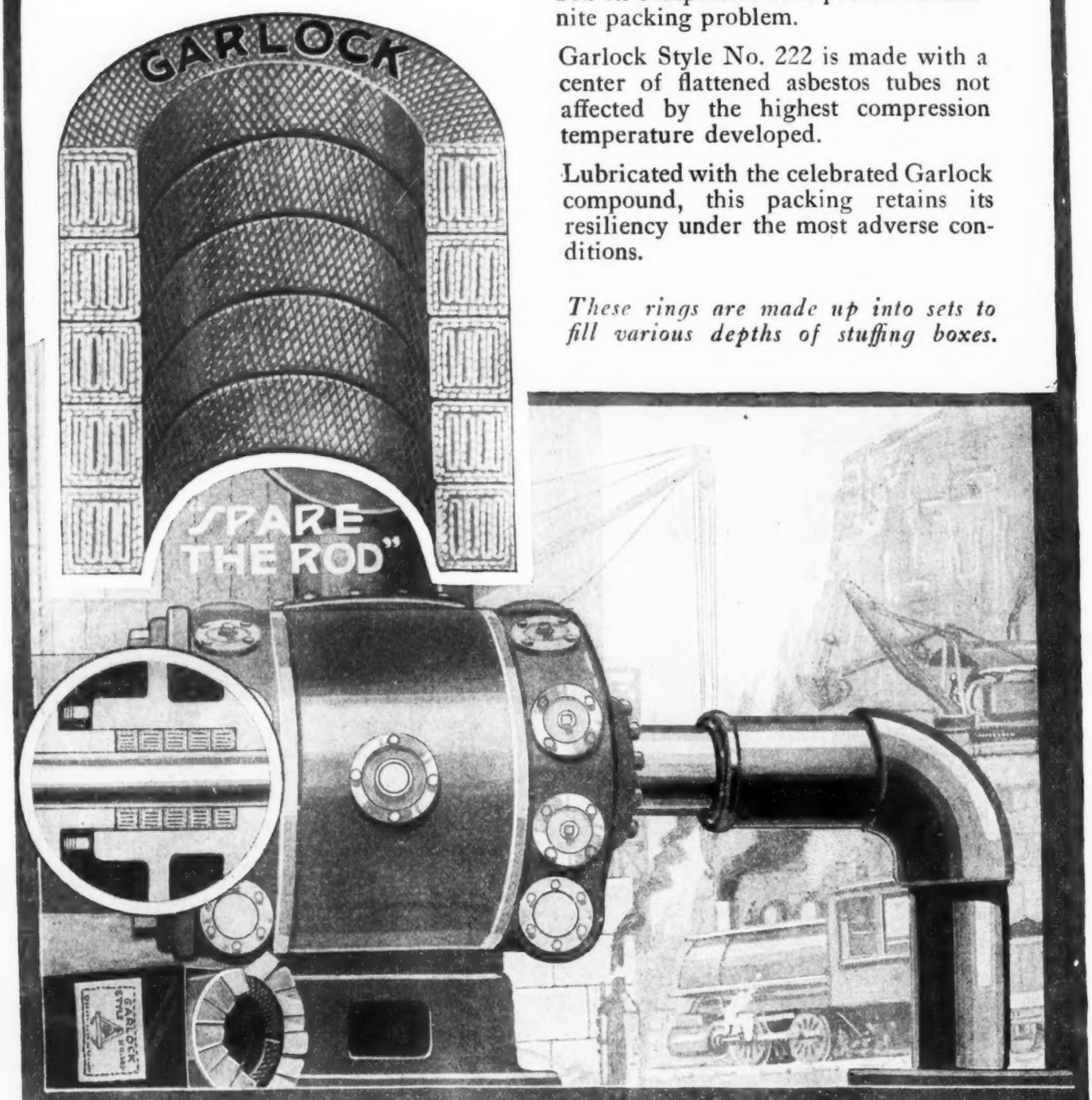
AIR COMPRESSOR PACKING

The maintenance of an air tight stuffing box on compressor rods presents a definite packing problem.

Garlock Style No. 222 is made with a center of flattened asbestos tubes not affected by the highest compression temperature developed.

Lubricated with the celebrated Garlock compound, this packing retains its resiliency under the most adverse conditions.

These rings are made up into sets to fill various depths of stuffing boxes.



GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

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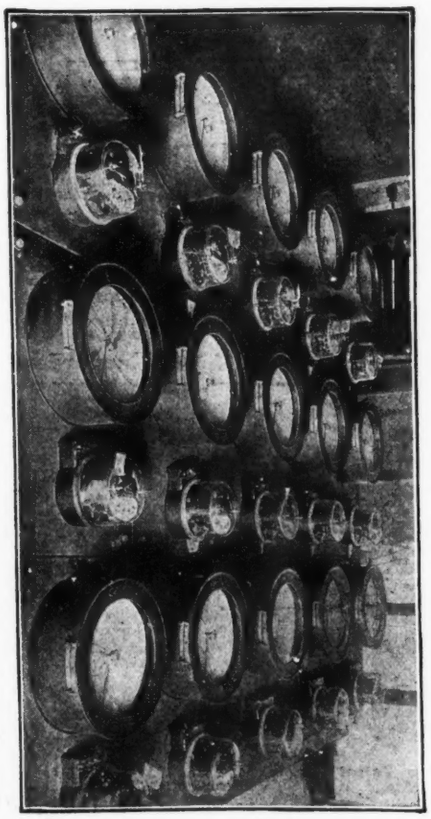
REPUBLIC

ONLY ELECTRICALLY OPERATED

FLOW METERS



Is every factor entering into power production and distribution in your plant on a basis of highest possible efficiency?

You cannot, of course, better your plant conditions until you have the means of knowing what your conditions are.

For that reason a great many of our leading manufacturers have installed the *Republic* System in their power plants.

They now have the means of knowing *when* the condition of maximum economy is attained, of determining *how* it can be obtained and maintaining it after it is attained.

Bulletin No. 8 contains complete information on the Republic—the only electrically operated flow meter.

REPUBLIC FLOW METERS CO.

2240 DIVERSEY BOULEVARD

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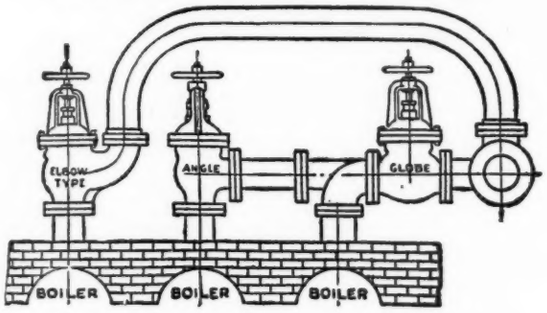
New York Philadelphia Pittsburgh Boston Detroit Atlanta Toronto

Republic System

No Shutdown From Backflow—

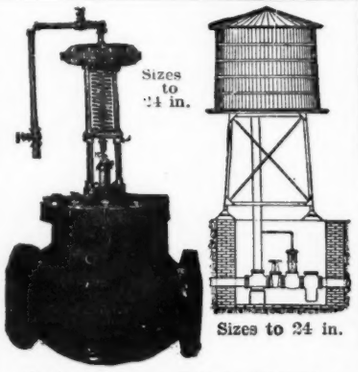
This Is But One of Many Advantages of Golden - Anderson Life and Property Insurance Valves



They Give Full Protection

1. Automatic closure follows the instant accident occurs. The remaining boilers cannot empty their steam through the rupture.
2. The Triple Acting Style also automatically closes on every boiler when a steam pipe bursts.
3. Make entrance of live steam into a cold boiler impossible.
4. Automatically cut in and cut out boilers, equalizing the pressure between them.
5. **The only valve of its kind that can be tested in service from the floor.**
6. The double Corliss dash pot insures perfect cushioning without pounding, spinning, or sticking.
7. Furnished in sizes to 20 inches in globe, angle or elbow pattern.

1960 Used by U. S. Steel Corporation

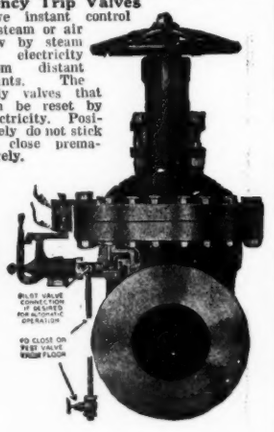


Golden-Anderson Patent Automatic Cushioned Controlling Altitude Valves

Automatically hold constant water level in reservoirs and tanks. Three ways of closing:—by water, by electricity and by hand. No floats inside or outside.

Golden-Anderson Patent Double Cushioned Quick Closing Emergency Trip Valves

Give instant control of steam or air flow by steam or electricity from distant points. The only valves that can be reset by electricity. Positively do not stick or close prematurely.



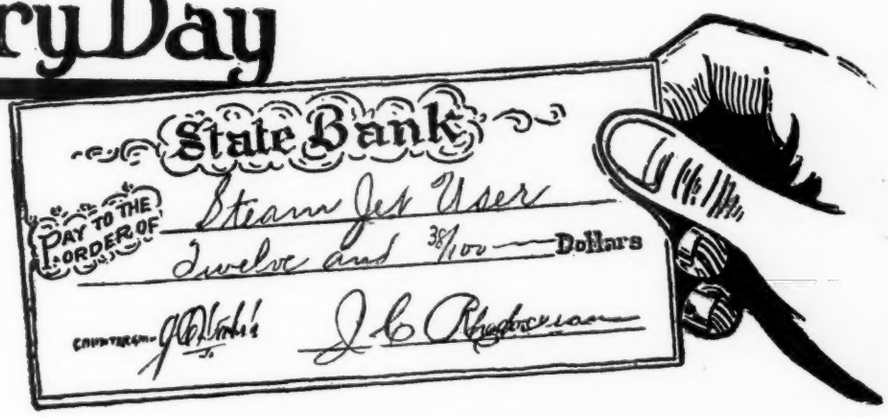
GOLDEN-ANDERSON

"Life and Property Insurance Valves"

Golden-Anderson Valve Specialty Company

1217 Fulton Building, Pittsburgh, Pa.

Hand Yourself a Check like this Every Day

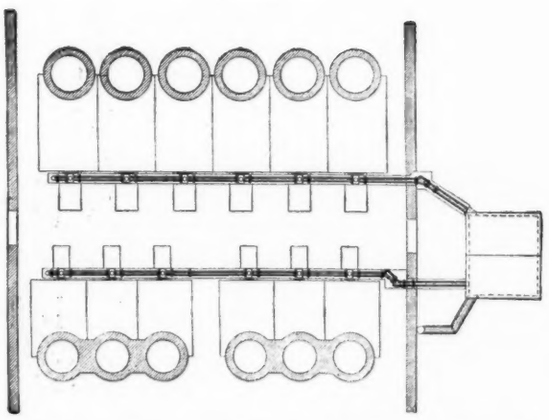


YES, that's what the King Paper Company of Kalamazoo, Michigan, are doing.

Virtually, they hand themselves a check every day—the amount of savings due to the installation of an American Steam Conveyor in their boiler room.

The following quotation is from a letter written by A. F. Meisterheim, Purchasing Agent:

> "The American Steam Ash Conveyor has now been in continuous use—night and day—for a little over three years and certainly has given us the very best of satisfaction.
>
> "The installation has a number of very good points to recommend it, such as cleanliness around the plant, the efficient and easy manner in which it handles the ash, and also its economy. The labor-saving problem in itself is very important, especially at this time when labor is scarce. We operate three shifts of eight hours each and find that *we have been able to save one man on each shift.*"



The diagram above shows how two 8-in. American Steam Ash Conveyors handle ashes from the plant of the King Paper Company, Kalamazoo, plant equipped with 12 Wickes boilers with Murphy stokers, totalling 3000 hp. Ashes delivered to pit outside.

The American Steam Ash Conveyor will enable you to cut overheads—to hand yourself a neat little check every day.

Why not investigate? It takes but a moment to sign the coupon below. Return it now.

CONVEYORS CORPORATION OF AMERICA
Formerly
AMERICAN STEAM CONVEYOR CORPORATION
Coal and Ash Handling Equipment

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326 West Madison Street

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AMERICAN STEAM CONVEYORS

CONVEYORS CORPORATION OF AMERICA
Chicago **New York**

We want to hand ourselves a check every day, as suggested in your ad in Power for Dec. 28, 1920. Tell us how the American Steam Ash Conveyor will help.

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Refer to Mr. .....

Position .....

Street .....

City ..... State .....

Present method of Ash Handling .....

Ideal Combus ti

can be had once in a

But—can you maintain them in regular operation?

By careful attention to every detail of boiler room practice, combustion conditions that are correct can be attained in almost every plant. But maintaining those correct conditions of draft, fuel and air supply, etc., day after day in routine operation is entirely another problem. Fluctuations of steam demand require changes in firing and damper position; varying fuel beds, different depths of fire, and any change in draft require changes in air supply; and all these variations are occurring continuously through the day.

AUTOMATIC COMBUSTION CONTROL
TRADE saves coa MARK
GRAY SYSTEM

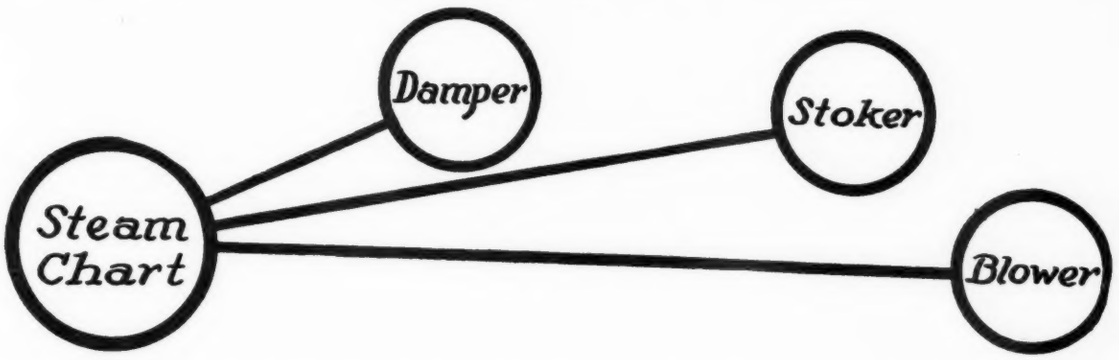
Automatic Fuel

Combustion Engineers

351 Machinery Hall, Chicago

s tion Conditions

n a while in every plant



The Gray System of Automatic Combustion control meets every change in the conditions which affect combustion, following the demand so closely that the fluctuations are not evident to the observer. Pre-determined conditions, decided upon at the time of installation, are maintained under all changes of load, draft, and fire.

Naturally the very close approach to the ideal of combustion makes possible increased capacity with present boiler equipment, and at a considerable saving in fuel. With the difficulties of power plant operation imposed by the present coal situation, the value of the thoroughly reliable combustion control provided by the Gray System is unusually great.

"Help For You"

A complete description of the methods and results of the Gray System should be read by every engineer and plant manager. Our book, "Automatic Combustion Control," will be sent upon request, and without obligation.

Saving Company

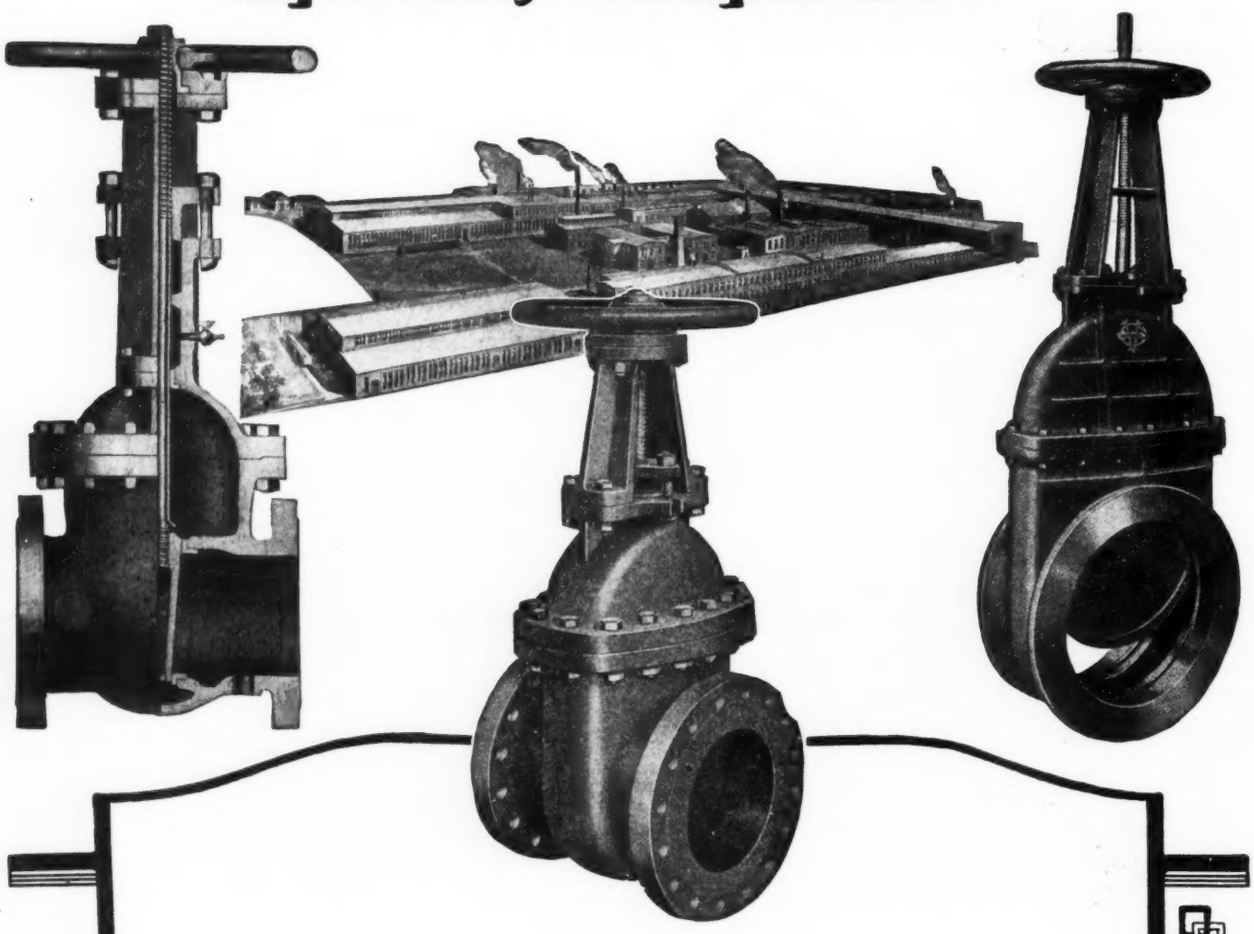
AUTOMATIC COMBUSTION CONTROL saves coal TRADE MARK GRAY SYSTEM

and Contractors

1062 Bulletin Bldg., Philadelphia

Chapman Valves

When you require the utmost, the unusual in Valves, Specify "Chapman."



The Power Engineer specifies CHAPMAN because he knows that each Chapman Valve is designed to fill some specific function in his Power Plant—and is the best valve that can be built for that service. ***Ask for the Chapman Valve Handbook No. 38.***

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The Chapman Valve Mfg. Co.,

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Pre-Heat Fuel Oil

Reilly Fuel Oil Heater

To insure proper vaporization of oil under the burners it must be pre-heated. The Griscom-Russell Co. have been manufacturers of fuel oil heaters for many years both for the U. S. Navy and Merchant Marine and for commercial requirements. Over 4,000,000 Boiler Horse Power is equipped with Fuel Oil Heaters of The Griscom-Russell Co. manufacture.

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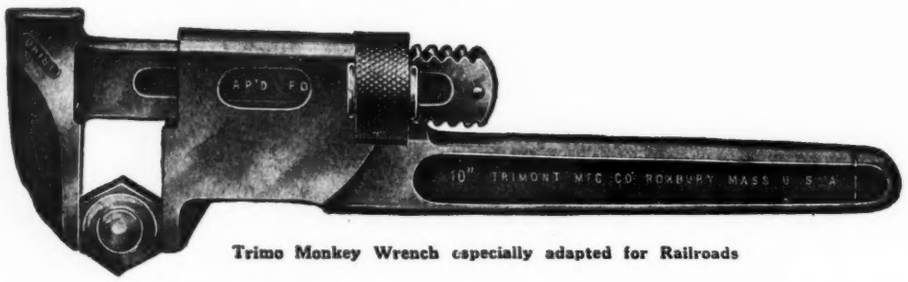
TRIMO

Trimo Pipe Wrench



Trimo Monkey Wrench especially adapted for Railroads

Trimo Chain Wrench

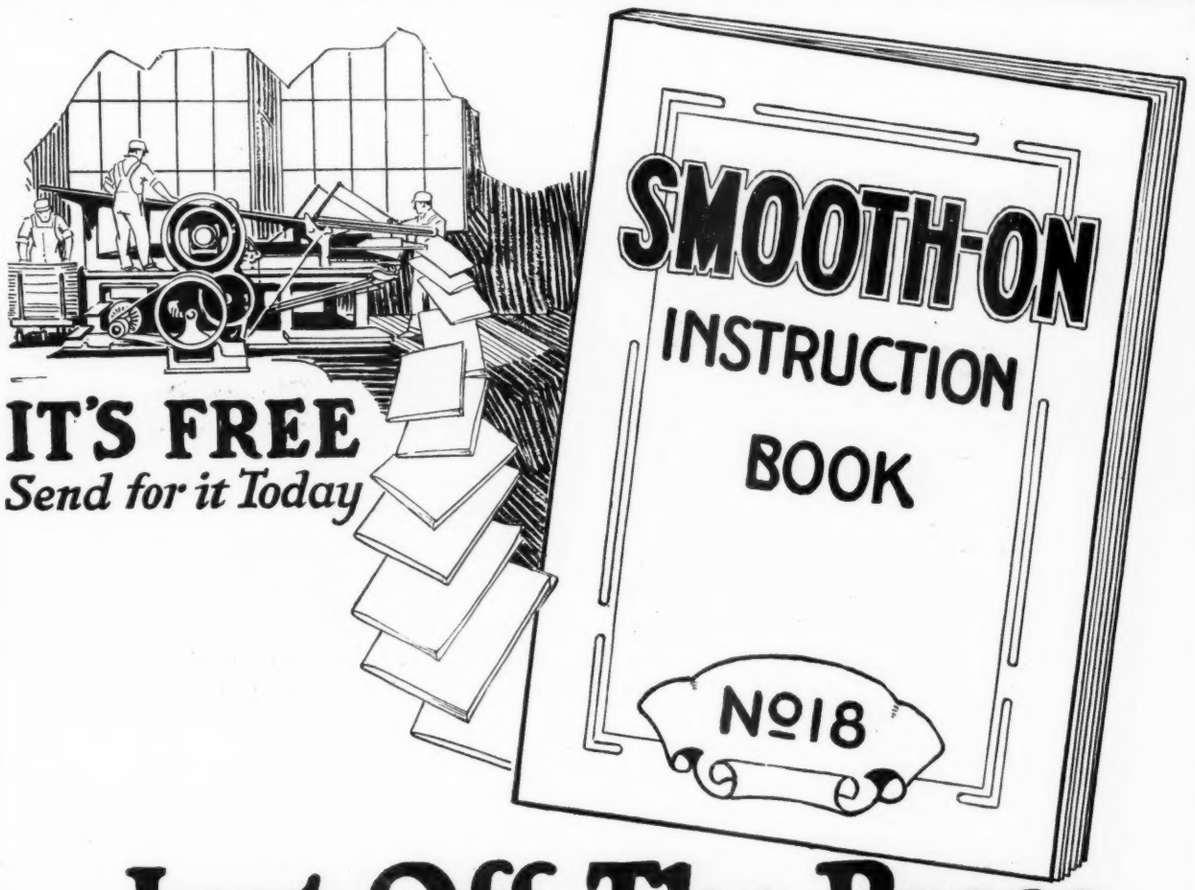
The Word Trimo

stands for good tools made by the Trimont Mfg. Co., which are the following:

The Trimo Pipe Wrench
The Trimo Chain Pipe Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut—and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

TRIMONT MFG. COMPANY
ROXBURY, MASS., U. S. A.



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Have you written for Smooth-On Instruction Book No. 18? It is just off the press and may contain just the hint you want for your own repair work.

Your copy is ready. All we want is a word from you and we'll send it along.

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the Cost of a Burt Oil Filter Is Not the Price We Ask for It.

FROM the very nominal initial price of the installation—you must subtract the saving in your oil consumption, which begins the *first day* you install the filter, and soon gets far beyond the first cost of the filter.

Large and small concerns all over the world are reclaiming their dirty but high priced oil by Burt Filters. Even the Standard Oil Company—*one concern not worrying about the increasing cost of oil*—endorses Burt Filters to the extent of having over 400 in their plants.

We want to furnish you with complete information about the modern economical method of oil filtration. May we mail the 128 page Burt Book?

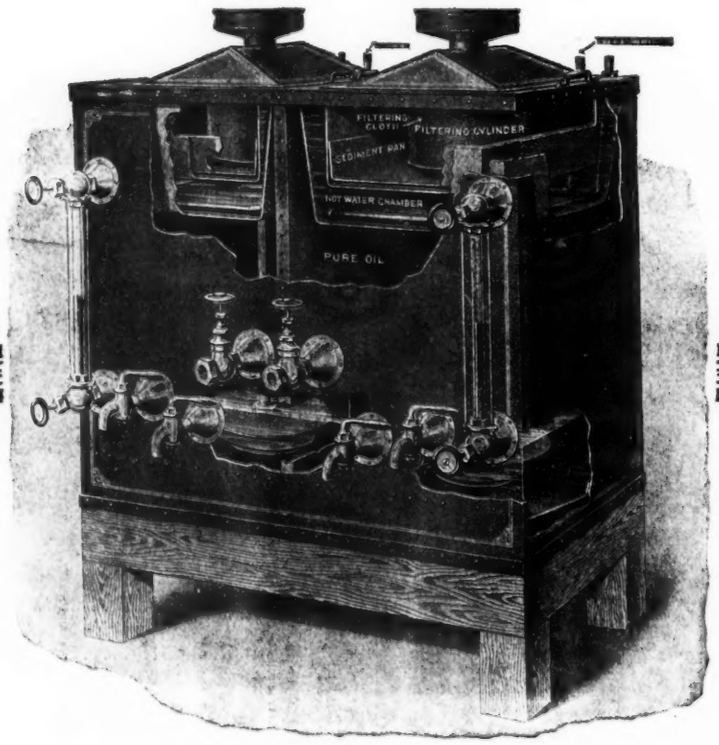
The Burt Manufacturing Co.

232 Main Street, Akron, Ohio, U. S. A.

Largest Manufacturers of Oil Filters in the World

Canada: Canadian Fairbanks Morse Co., Montreal

The BURT BOOK also describes and illustrates our Ventilators and Exhaust Heads.



Double Unit Type

We carry a complete stock of Ventilators and Exhaust Heads as well as Oil Filters and are in a position to make immediate delivery.

Burt Oil Filter

Money in Exhaust Steam

How to Extract it

EVERY pound of exhaust steam escaping from your plant proclaims that you are throwing away at least 90% of all the heat that was originally put into that steam. With but few exceptions all plants can be improved by correctly using the exhaust, if one but knows how.

To save money from exhaust steam apply the Cochrane Feed Water Heater and the Cochrane "KNOW HOW." The latter is an accumulated fund of knowledge based upon our experience in steam plants of all kinds, including Condensing and Non-condensing Power Plants, Heating Systems, Refrigerating Plants, Salt Works, Railroad Round Houses, Laundries, Hotels and Office Buildings, Dye Houses, Sugar Refineries, Steel Mills, etc., etc.

For more than thirty years we have studied the utilization of exhaust steam in industrial plants. That which we have done in thousands of plants, some probably like yours, enables us to make correct estimates and guarantees as to what we can do for you.

Write us a letter stating your conditions and we will draw up an estimate which will be clear and explicit, so that you can understand what we propose to do, what it will cost and what your savings will be.

Ask for treatise on "Profitable Utilization of Exhaust Steam"

H.S.B.W.-COCHRANE CORPORATION

Formerly Harrison Safety Boiler Works

17th and Clearfield Streets, PHILADELPHIA, PA.

Manufacturers of the celebrated Cochrane Lines, including open feed water heaters, steam stack and cut-out valve heaters and receivers, metering heaters and independent meters, Sorge-Cochrane hot-process water softeners, steam and oil separators, and multiport back pressure, atmospheric relief, flow and check valves.

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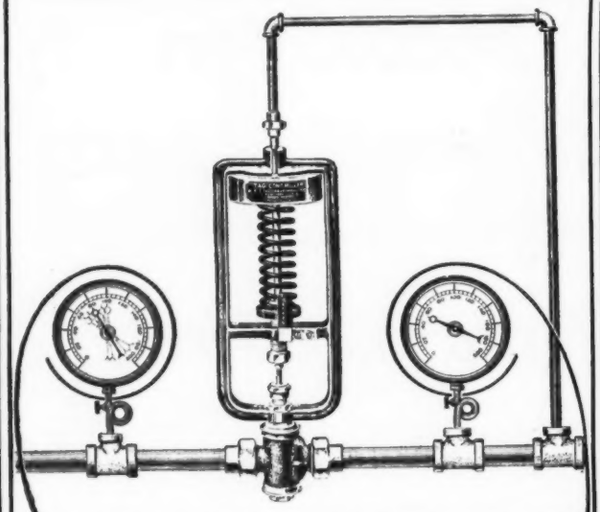

UNEVEN PRESSURE MADE CONSTANT

A varying pressure in your supply line can't impair the working efficiency of any apparatus requiring a constant pressure—with the TAG Self-Operating Pressure Controller straddling the motive power and doggedly gripping the predetermined pressure.

Day in and day out, *constant pressure is automatically maintained*—without any other attention of the engineer to the controller than to "set it and forget it."

What a difference between this simple, economical method that really controls the pressure, and the old wasteful, time-consuming way of juggling the hand valve, which only approximates the desired pressure!

Put a TAG Controller on the pressure line—immediately, uneven pressure is made constant.

Write for C.J. TAGLIABUE MFG. CO. 18 TO 88 Thirty-Third Street BROOKLYN, N.Y. *Bulletin P-488*

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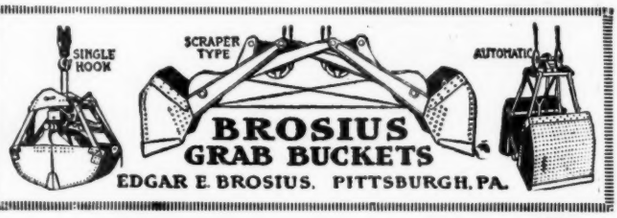

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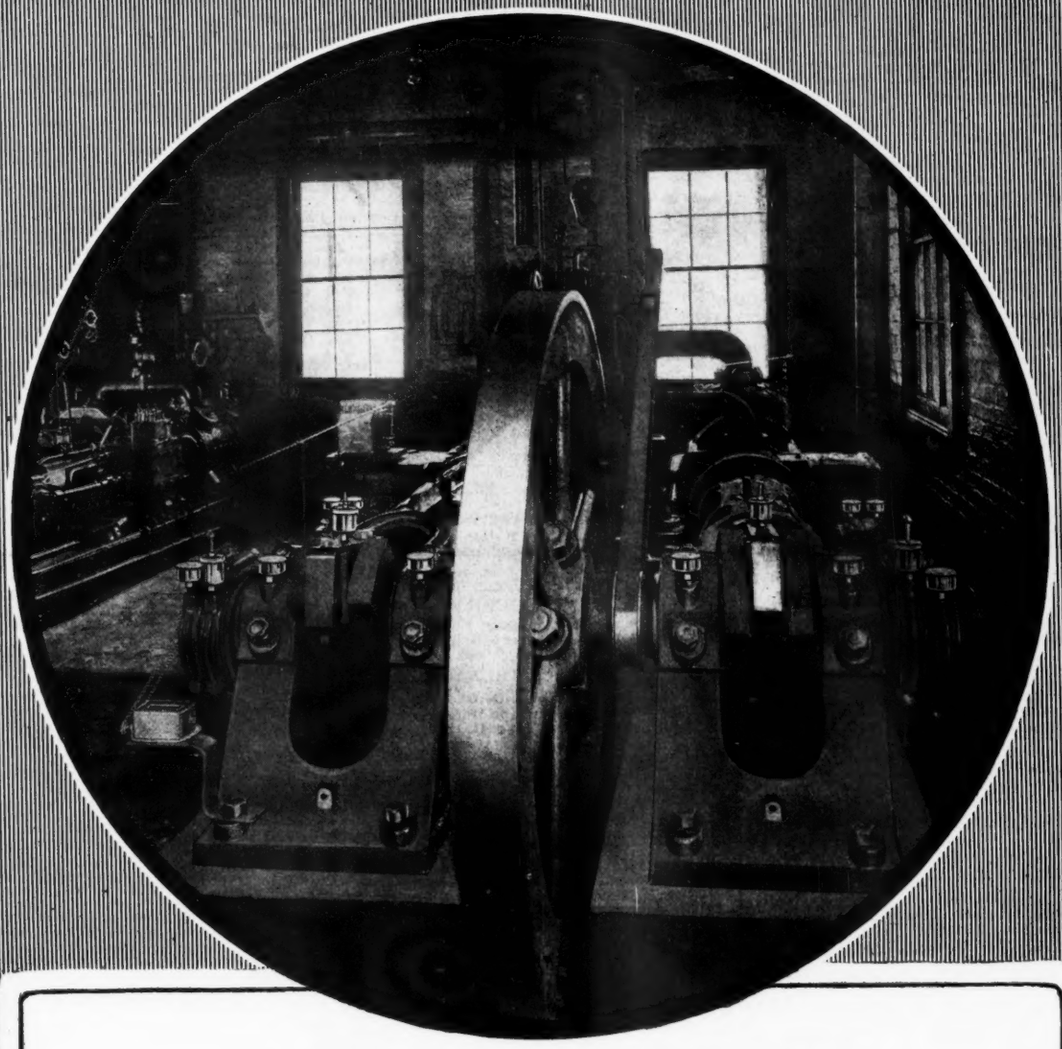

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on this machine and they never have any bearing trouble whatever. The largest gas company in the world who own and run this machine use Albany Grease on every bearing in their big plants and stations. From long experience they have found Albany Grease to give them perfect lubrication service.

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ADD 5 WORDS for box number in undisplayed ads if replies are to any of our offices. There is no extra charge for forwarding replies.

DISCOUNT OF 10% if one payment is made in advance for 4 consecutive insertions of undisplayed ad.

ADS IN DISPLAY TYPE—Space is sold by the inch (30 in. to a page), the price depending upon total space used within a year, some space to be used each issue.

RATE PER INCH for ads in display space:
1 to 3 in., $5.00 an in. 15 to 49 in., $4.60 an in.
4 to 7 in., $4.80 an in. 50 to 99 in., $4.40 an in.
8 to 14 in., $4.70 an in. 100 to 199 in., $4.30 an in.

POSITIONS VACANT

EMPLOYMENT

POSITIONS WANTED

POSITIONS VACANT

Canada

EXPERIENCED boiler designer wanted by large manufacturing plant in Ontario, Canada. P-564, Power.

GRADUATED mechanical engineer wanted, preferably with pulp and paper mill experience for large Canadian sulphite mill. Please state age, experience, salary expected, and inclose copies of references. P-571, Power.

Indiana

CHIEF engineer wanted for paper mill power plant, middle west. Must be familiar with turbine generator and able to get highest results from modern power plant. State age, experience and salary wanted. P-566, Power, Old Colony Bldg., Chicago.

EMPLOYMENT SERVICE

EXECUTIVES qualified for salaries of $2,500 to $25,000 and upwards, are invited to communicate in strict confidence with the undersigned, who will conduct preliminary negotiations for such positions. The procedure used is peculiar to this service, differing essentially from all others, and is constructive and initiative; applied individually, and in no way jeopardizing present connections. Established 1910. Send name and address only for particulars. R. W. Bixby, Inc., 306 Lockwood Building, Buffalo, New York.

POSITIONS WANTED

Connecticut

CHIEF engineer desires position; have had 20 years' experience with steam, electric equipment stoker and hand fired boilers, Corliss & Slide valve engines, turbines, a.c. and d.c. generators, pumps, condensors, etc. PW-560, Power.

Massachusetts

CHIEF engineer, age 30, holding first-class Massachusetts license; at present employed in large central station; will be at liberty Jan. 1, 1921. PW-567, Power.

New Hampshire

BOILER plant engineer, competent to supervise installation operation and maintenance of all modern equipment, technical knowledge; can get results commensurate with fuel and equipment furnished. Minimum salary $4,000. PW-529, Power.

New York

TECHNICAL graduate, age 33, ten years' shop work, drafting, designing and layout of general equipment for industrial plants, including power plant; connection as designing draftsman or engineer desired; any location considered. PW-570, Power.

POSITIONS WANTED

Pennsylvania

MASTER mechanic, thorough knowledge of electrical and mechanical installations, power plant and factory machinery. At present employed in charge of large factory. Age 39. Married. PW-544, Power, Real Estate Trust Bldg., Phila.

AGENTS AND SALESMEN

Salesman Wanted

We manufacture small vertical upright boilers and steam engines. We desire to meet a high-grade engineering salesman who has specialized on boiler and engine sales, who right now knows the field, knows the users of this class of machinery and who can begin to show results immediately. In your reply tell us all about yourself and what you have done and how quickly you would be ready to begin this work for us. We are located at Chicago. P-549, Power, Old Colony Bldg., Chicago.

Salesmen and Engineers

Sell our "Everlasting" Dead Plate for steam boilers. Lasts forever—25% commission. Write for proposition. Indestructible Dead Plate Co., 1031 N. Clark St., Chicago.

Sales Agents

To sell a new line of fuel saving devices; an opportunity to get in on the ground floor. Some choice territories are still open. AS-569, Power, Real Estate Trust Bldg., Philadelphia.

Sales Engineer Available

Sales engineer in Pittsburgh territory wishes to represent two or three power appliance companies on a salary and commission basis. AS-568, Power, Real Estate Trust Bldg., Philadelphia.

Salesmen Wanted

Well-known manufacturer of soot cleaners desires clean-cut representatives to handle sale of cleaners for return tubular boilers only. This cleaner is in use in thousands of plants, but thousands more need it. A highly profitable proposition for a real salesman; attractive commission basis. AS-535, Power, Real Estate Trust Bldg., Philadelphia.

SPECIALTY SALESMEN WANTED

to sell a high grade steam indicator on commission basis. Here's a very attractive proposition to salesmen calling on steam plants. Write for catalog and terms.

TRILL INDICATOR CO., Corry, Pa.

PATENT ATTORNEYS

PATENTS. C. L. Parker, patent attorney, formerly member Examining Corps, U. S. Patent Office, McGill Bldg., Washington, D. C. Inventor's handbook sent upon request.

WANTED

Magazines Wanted

POWER and other technical periodicals, scientific journals, reports, proceedings, etc., published in United States or Europe, bought and sold. Catalogs on request. The H. W. Wilson Co., 958 University Avenue, New York, N. Y.

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Boilers

6 Hor. Ret tubular boilers, 150 HP., 100 lb. pressure, 72" x 18', also 4 Heine boilers, 385 HP. N. Y. Sanitary Utilization Co., 149 Remsen St., Brooklyn, New York.

Boilers

Two 100 hp. Murray, marine type boilers, 5 years' old, complete with fittings, bretchen, and 96 ft. smoke stack; all in good condition; 150 lb. pressure; Hartford inspection. The Sidney Municipal Service, Sidney, Neb.

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Engine Generator Sets

2—250 or 300 K.W. or larger generators, 250 volts, direct current, directly connected to simple engines (not compound), either 4 valve, piston valve or Unaflow type.

Give name of manufacturer, shop number, age, condition, floor space occupied, and all other information at hand.

Madison Coal Corporation
Purchasing Department
902 S. Michigan Ave., Chicago, Ill.

WANTED
750 gallon electric
CENTRIFUGAL UNDERWRITERS' FIRE PUMP
with 75 hp., 230 volt, D.C. motor. Used.
MAHER ENGINEERING CO.
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FOR SALE
4—175 hp. H.R.T. Boilers 125 lbs.
6—150 hp. H.R.T. Boilers 100 lbs.
10—250 hp. B. & W. Boilers 125 lbs.
2—125 hp. B. & W. Boilers.
1—Worthington Pump, 16 x 25 x 15 x 15.
Boilers, Engines and Tanks in stock.
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2—8000 sq.ft. Wheeler Admiralty type, Surface Condensers, without Auxiliaries.

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1—5400 sq.ft. Wheeler Admiralty type Condenser complete with all Fittings and Auxiliaries.

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1—200 k.w. G. E., 60 Cycle, 3 Phase, 2300 Volts, D. C. to Tandem Compound Automatic Engine, 150 r.p.m. complete.

1—325 kva. Revolving Feld E. T. Alternator only, 60 Cycle, 3 Phase, 2300 Volt, 164 r.p.m.

2—330 k.w. Westinghouse R. F. Engine type Alternators, 25-30 Cycle, 3 Phase, 400-440 V., D. C. to Cross Compound Allis Corliss Engine.

1—400 k.w. Crocker-Wheeler Revolving Field Engine type Alternator, 60 Cycle, 3 Phase, 220-440 Volt, 225 r.p.m. No Engine.

ALTERNATORS

1—240 kw. General Electric, Revolving Field Engine type Alternator, 60 Cycle, 3 Phase, 220-440 Volts, D.C. to Ames Tandem Compound Condensing Engine.

1—300 kva. Allis-Chalmers, Revolving Field Engine type Alternator, 60 Cycle, 3 Phase, 220-440 Volts, D.C. to Skinner Heavy Duty Automatic Engine.

1—1200 kw. Westinghouse, Rev. Field, 60 Cycle, 3 Phase, 440 Volt Alternator, D.C. to Cross Compound Heavy Duty Corliss Engine, 90-day delivery.

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Surplus stock taken over from the Du Pont Chemical Co. and other plants

PRACTICALLY NEW

Used Six Months to Three Years
Offered Subject to Any Inspection

No.	Size, Hp.	Make	Pressure, Lb.
9	600	Edge Moor (Ohio Standard)	200
13	600	Edge Moor	200
22	600	Edge Moor	160
1	813	Edge Moor (A. S. M. E.)	200

Above located in du Pont Chemical Company's Plant at Hopewell, Virginia

10	512	Stirling Class S No. 26	160
2	512	Stirling Class S No. 26	160
1	823	Stirling M-30 (A. S. M. E.)	200
2	550	Edge Moor	150
2	238	Edge Moor	150
4	231	Edge Moor (Ohio Standard)	150
1	199	Edge Moor	150
1	100	Smith HRT	100
1	50	Ames Locomotive	100

Above boilers located at Du Pont Chemical Company's Plant, Carney's Point, N. J.

MISCELLANEOUS

No.	Size, Hp.	Make	Pressure, Lb.
3	250	Heine	150
1	250	Heine	150
1	400	Stirling	150
2	400	Wickes	150
2	250	Wickes	165
2	250	Wickes	150
1	300	Wickes	150
1	225	Geary	150
1	250	B. & W.	125
2	210	B. & W.	125
1	347	B. & W.	160
1	200 U.S.A.	Scotch Marine	175
1	125	Scotch Marine	125
1	78 x 20	H.R.T.	135
8	72 x 18	H.R.T.	125
2	84 x 18	H.R.T.	100
2	66 x 16	H.R.T.	125
2	66 x 16	H.R.T.	80

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3—39 in. x 75 ft. 1—60 in. x 92 ft. 6—36 in. x 60 ft
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We invite your inspection of any of the equipment we have in stock. Inspections can be made at any time Quotations are made for prompt acceptance and subject to prior sale.

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New Motors in Stock *Immediate Delivery*

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2—2-hp., 550-volt, 1725-r.p.m., Type "CD" Westinghouse, 40° rise.
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16—3-hp., 550-volt, 1340-r.p.m. Crocker-Wheeler Motors, 40° rise.
8—3-hp., 550-volt, 1200-r.p.m., Type "SK" Westinghouse, 40° rise.
2—3¼-hp., 550-volt, 900-r.p.m., Type "DC", comp. wound, totally enclosed Westin ghouse Motors, 40° rise.
2—5-hp., 550-volt, 1800-r.p.m., Type "MC" General Electric Motors.
1—5-hp., 550-volt, 1300-r.p.m., Type "RC" second-hand General Electric Motor, 50° rise.
9—5-hp., 550-volt, 1160-r.p.m. Crocker-Wheeler Motors, 40° rise.
4—5-hp., 550-volt, 720-r.p.m., Type "SK", totally enclosed Westinghouse Motors, special Frick Motors, 40° rise.
5—7½-hp., 550-volt, 1300-r.p.m., Type "RC" C. F., 50° rise.
1—7½-hp., 550-volt, 950-r.p.m., Type "7½-1" comp.wd.,C-W.,40°rise.
3—10-hp., 550-volt, 1800-r.p.m., Type "RC" General Electric, 50° rise.
5—10-hp., 550-volt, 1700-r.p.m., Type "SK" Westinghouse, 40° rise.
7—10-hp., 550-volt, 1150-r.p.m., Type "SK" Westinghouse Motors.
1—15-hp., 550-volt, 1250-r.p.m., Type "RC" General Electric, 50° rise.
1—15-hp., 550-volt, 1800-r.p.m., Type "RC", comp. wound General Electric Motor, 50° rise.
1—30-hp., 550-volt, 900-r.p.m., Type "RC", shunt wound General Electric Motor, 40° rise.
1—40-hp., 550-volt, 875-r.p.m., Type "RC", comp. wound General Electric Motor, 50° rise.
3—50-hp., 550-volt, 1700-r.p.m., Type "SK", comp. wound Westinghouse Motors, 40° rise.
1—75-hp., 550-volt, 1700-r.p.m., Type "SK," comp. wound Westg.

230-VOLT, D.C. MOTORS

6—1-hp., 230-volt, 1200-r.p.m., Type "CD" Westinghouse Motors.
2—2-hp., 230-volt, 1180-r.p.m., Type "CD" Westinghouse, 40° rise.
5—3-hp., 230-volt, 1800-r.p.m., comp. wd. Crocker-Wheeler, 40° rise.
2—3-hp., 230-volt, 1700-r.p.m., Type "MC", comp. wound, mine type General Electric Motors, 40° rise.
5—3-hp., 230-volt, 1725-r.p.m., Type "CD", form comp. Westinghouse Motors, 40° rise.
1—3-hp., 230-volt, 1150-r.p.m., Type "MC" General Electric Motor.
27—3-hp., 230-volt, 1150-r.p.m., Type "SK" Westinghouse, 40° rise.
5—5-hp., 230-volt, 960-r.p.m. Crocker-Wheeler Motors.
3—7½-hp., 230-volt, 1800-r.p.m., Type "SK" Westinghou e, 40° rise.
1—7½-hp., 230-volt, 1700-r.p.m., type "RC", comp. wound General Electric Motor, 40° rise.
4—7½-hp., 230-volt, 1425-r.p.m. Crocker-Wheeler Motors, 40° rise.
2—7½-hp., 230-volt, 500-1500-r.p.m., Type "SK" Westinghouse Motors, 40° rise. Second-hand.
19—7½-hp., 230-volt, 1150-r.p.m., Type "SK" Westinghouse Motors.
2—7½-hp., 230-volt, 875-r.p.m., comp. wound C-W, 40° rise.
1—10-hp., 230-volt, 1700-r.p.m. Type "RC", comp. wound General Electric Motor, 40° rise.
1—10-hp., 230-volt, 1150-r.p.m., Type 'RC", comp. wound General Electric Motor, 50° rise.
6—10-hp., 230-volt, 1150-r.p.m., Type "SK" Westinghouse, 40° rise.
1—15-hp., 230-volt, 1700-r.p.m., Type "SK" Westinghouse, 40° rise.
2—15-hp., 230-volt, 1700-r.p.m., Type "RC", comp. wound General Electric Motors, 50° rise.
2—15-hp., 230-volt, 400-1600-r p.m., sh. wound Reliance, 40° rise.
1—15-hp., 230-volt, 1150-r.p.m., Type "RC" General Electric Motor, comp. wound, 50° rise.
2—15-hp., 230-volt, 1250-r.p.m., Type 'SK" Westinghouse, 40° rise.
1—15-hp., 230-volt, 850-r.p.m., Type "RC" General Electric, 50° rise.
2—15-hp., 230-volt, 850-r.p.m., Type "SK" Westinghouse, 40° rise.
1—20-hp., 230-volt, 1700-r.p.m., Type "SK" Westinghouse, 40° rise.
1—20-hp., 230-volt, 1700-r.p.m., Type "RC", Form Comp. General Electric Motor, 50° rise.
1—25-hp., 230-volt, 775-r.p.m., Type "RC", comp. wound General Electric Motor, 40° rise.
5—30-hp., 230-volt, 1700-r.p.m., Type "SK" Westinghouse, 40° rise.
1—30-hp., 230-volt, 1500-r.p.m., shunt wound Reliance, 40° rise.
1—35-hp., 230-volt, 1600-r.p.m. Reliance Motor, 40° rise.
1—40-hp., 230-volt, 1700-r.p.m., Type "SK" Westinghouse Motor.
1—50-hp., 230-volt, 1700-r.p.m., Type "SK" Westinghouse, 40° rise.

110-220-VOLT, A.C. MOTORS

2—¼-hp., 110/220-volt, 1725-r.p.m., Type "BA" Wagner, 40° rise.
1—½-hp., 110/220-volt, 1750-r.p.m., single phase, 60-cycle Century Motor, 40° rise.
3—½-hp., 110/220-volt, 1140-r.p.m., Type "BA" Wagner, 40° rise.
3—¾-hp., 110/220-volt, 1750-r.p.m., Type "RS" Century, 40° rise.
3—¾-hp., 110/220-volt, 1725-r.p.m., Type "BA" Wagner Motors.
1—¾-hp., 110/220-volt, 1165-r.p.m., single phase Century, 40° rise.
3—¾-hp., 110/220-volt, 1140-r.p.m., Type "BA" Wagner, 40° rise.
7—1-hp., 110/220-volt, 1750-r.p.m., single phase, 60-cycle Century Motors, 40° rise.
1—1-hp., 110/220-volt, 1725-r.p.m., Type "BA" Wagner, 40° rise.
2—1-hp., 110/220-volt, 1165-r.p.m., 60-cycle Century Motors, 40° rise.
8—1-hp., 110/220-volt, 1150-r.p.m., Type "BA" Wagner, 40° rise.
3—1½-hp., 110/220-volt, 1165-r.p.m., single phase Century Motors.
7—1½-hp., 110/220-volt, 1150-r.p.m., Type "BA" Wagner Motors.
11—2-hp., 110/220-volt, 1750-r.p.m., single phase, 60-cycle, Century Motors, 40° rise.
9—2-hp., 110/220-volt, 1750-r.p.m., Type "BA", single phase, 60-cycle Wagner Motors, 40° rise.
11—2-hp., 110/220-volt, 1150-r.p.m., single phase, 60-cycle Century Motors, 40° rise.
11—2-hp., 110/220-volt, 1165-r.p.m., single ph., 60-cy. Wagner, 40° rise.
7—3-hp., 110/220-volt, 1750-r.p.m., Type "BA", single phase, 60-cycle Wagner Motors, 40° rise.
14—3-hp., 110/220-volt, 1750-r.p.m., single phase, 60-cycle Century.
6—3-hp., 110/220-volt, 1150-r.p.m., single phase, 60-cycle Century Motors, 40° rise.
2—3-hp., 110/220-volt, 1160-r.p.m., Type "BA" Wagner, 40° rise.
2—5-hp., 110/220-volt, 1750-r.p.m., Type "SP", 60-cycle Century Motors, 40° rise.
2—½-hp., 104/208-volt, 1750-r.p.m., Century, vertical, 40° rise.
1—1-hp., 104/208-volt, 1750-r.p.m. Century Motor, vertical, 40° rise. Second-hand.
1—1-hp., 110-volt, 1200-r.p.m., Type "KQ 122", 2-phase General Electric Motor, 40° rise.
1—15-hp., 110-volt, 1050-r.p.m., comp. wound Watson Motor, 40° rise. Second-hand.
2—3-hp., 115-volt, 1750-r.p.m. Robbins & Myers, D.C., shunt wound Motors, 40° rise.

220-VOLT, A.C. MOTORS

1—1-hp., 220-volt, 3600-r.p.m., Type "KT" General Electric, 40° rise.
7—1-hp., 220-volt, 1800-r.p.m., Type "KQ", 2-ph. G. E., 50° rise.
16—1-hp., 220-volt, 1800-r.p.m., Type "KT" General Electric, 50° rise.
1—1-hp., 220-volt, 1750-r.p.m. Robbins & Myers Motor, second-hand.
1—1-hp., 220-volt, 1200-r.p.m., Type "KQ", 2-phase G. E., 40° rise.
1—1-hp., 220-volt, 1200-r.p.m. Crocker-Wheeler Motor.
5—1½-hp., 220-volt, 1200-r.p.m., Type "KT", 3-phase, 60-cycle General Electric Motors, 50° rise.
1—2-hp., 220-volt, 1725-r.p.m., Type "CSA ', 2-phase Westinghouse.
2—2-hp., 220-volt, 1200-r.p.m., Type "KT" General Electric, 50° rise.
1—3-hp., 220-volt, 1800-r.p.m., Type "KT" General Electric, 50° rise.
1—3-hp., 220-volt, 1720-r.p.m. Swaby Vertical Motor, 40° rise.
6—3-hp., 220-volt, 1130-r.p.m., 3-phase, 60-cycle C.W., 40° rise.
1—5-hp., 220-volt, 1800-r.p.m., Type "CS" Westinghouse Motor.
7—5-hp., 220-volt, 1800-r.p.m., Type "KT" General Electric, 50° rise.
2—5-hp., 220-volt, 1720-r.p.m. Crocker-Wheeler Motors, 40° rise.
1—5-hp.,220-volt, 1720-r.p.m., Type "BP", 3-phase, 60-cycle Wagner Motor, 40° rise.
1—7½-hp., 220-volt, 1800-r.p.m., Type "KT" G. E., 40° rise.
1—7½-hp., 220-v., 1740-r.p.m., Type "CS,", 3-ph. Westg., 50° rise.
1—7½-hp., 220-volt, 1500-r.p.m., Type "KT" 302, 25-cycle General Electric Motor, 40° rise.
5—7½-hp., 220-v., 1200-r.p.m., Type "KT" General Electric, 50° rise.
1—7½-hp., 220-volt, 1140-r.p.m., Type "BN" Wagner, 40° rise.
12—10-hp., 220-volt, 1800-r.p.m., Type "CS" Westinghouse, 40° rise.
1—10-hp., 220-volt., 1150-r.p.m. Century, second-hand, 40° rise.
1—10-hp., 220-volt, 1900-r.p.m., Type "CS" Westinghouse Motor.
2—15-hp., 220-volt, 1200-r.p.m., Type "KT" General Electric Motors.
1—15-hp., 220-volt, 1140-r.p.m., Type "BW" Wagner Motor, 40° rise.
1—20-hp., 220-volt, 1800-r.p.m., Type "CS", 60-cycle Westinghouse.
1—20-hp., 220-v., 12 00-r.p.m., Type "CS," 60-cyc. Westg., 40° rise.
1—20-hp., 220-volt, 860-r.p.m. Westinghouse Motor, 40° rise.
4—25-hp., 220-v., 1800-r.p.m., Type "CS," 60-cyc., Westg., 40° rise.
3—25-hp., 220-volt, 1200-r.p.m., Type "KT", Form "K", 60-cycle General Electric Motors, 50° rise.
1—30-hp., 220-volt, 865-r.p.m. Allis-Chalmers, second hand, 40° rise.
2—40-hp., 220-volt, 1800-r.p.m., Type "KT", Form "K", 60-cycle General Electric Motors.
7—50-hp., 220-volt, 1800-r.p.m., Type "KT", Form "K", 60-cycle General Electric Motors, 40° rise.
1—60-hp., 220-volt, 1800-r.p.m., Type "K" General Electric, 50° rise.
2—75-hp., 220-volt, 1800-r.p.m., Type "KT", Form "K", 60-cycle General Electric Motors, 40° rise.

440-VOLT, A.C. MOTORS

1—¾-hp., 440-volt, 1140-r.p.m., Type "CSA" Westinghouse Motor.
1—1-hp., 440-volt, 1800-r.p.m., Type "KT," 60-cycle G.E.
2—1-hp., 440-v., 1800 r.p.m., Type "KT," Form "K," 60-cycle, G. E.
1—1½-hp., 440-volt, 1800-r.p.m., Type "KT" General Electric Motor.
2—2-hp., 440-volt, 1200-r.p.m., Type "KT", Form "K", 60-cycle General Electric Motors, 50° rise.
1—3-hp., 440-volt, 1800-r.p.m., Type "KT", Form "K", 60-cycle General Electric Motors, 50° rise.
2—3-hp., 440-volt, 1200-r.p.m. Crocker-Wheeler Motors.
20—5-hp., 440-volt, 1800-r.p.m., Type "KT", Form "K", 60-cycle General Electric Motors, 50° rise.
1—5-hp., 440-volt, 1800-r.p.m., Type "CS" Westinghouse Electric.
3—5-hp., 440-volt, 1800-r.p.m., Crocker-Wheeler Motors, 40° rise.
2—5-hp., 440-volt, 900-r.p.m., Type "KT," 3-phase, 60-cycle G.E.
2—5-hp., 440-volt, 1150-r.p.m. Crocker-Wheeler Motors.
5—7½-hp., 440-v., 1800-r.p.m., Type "KT," Form "K" G.E., 40° rise.
3—10-hp., 440-volt, 1800-r.p.m., Type "CS" Westinghouse, 40° rise.
1—10-hp., 440-v., 11 65-r.p.m., Type "AS" Century, 40° rise. Sec. hd.
2—15-hp., 440-volt, 1200-r.p.m., Type "KT," Form "K" G. E.
1—20-hp., 440-volt, 1200-r.p.m., Type "KT" form "K" G.E.
2—25-hp., 440-volt, 1800-r.p.m., Type "CS" Westinghouse, 50° rise.
2—40-hp., 440-volt, 1200-r.p.m., Type "KT," Form "K" G. E.
1—50-hp., 440-v., 1800-r.p.m., Type "KT," Form "K" G. E., 40° rise.
3—50-hp., 440-volt, 1800-r.p.m., Type "CS" Westinghouse, 40° rise.
1—50-hp., 440-v., 1200-r.p.m., Type "KT," Form "K" G. E., 40° rise.
1—50-hp., 440-volt, 900-r.p.m., Type "KT" G. E., 40° rise.
1—60-hp., 440-volt, 1800-r.p.m., Type "KT" G. E., 50° rise.
2—75-hp., 440-v., 1800-r.p.m., Type "KT," Form "K" G. E., 40° rise.
1—75-hp., 440-volt, 1800-r.p.m., Type "CS" General Electric, 40° rise.
2—100-hp., 440-volt, 1800-r.p.m., Type "KT" G. E., 40° rise.
1—100-hp., 440-volt, 860-r.p.m., Type "CS" Westgh., 40° rise.

HARRIS PUMP & SUPPLY COMPANY
"THE BIG MOTOR HOUSE"
316-322 SECOND AVE. { PITTSBURGH, PA. } 319-321 FIRST AVE.

Reliable—POWER PLANT MACHINERY

STEAM ENGINES

1—17 x34 x 48 Hamilton, cross compound, heavy duty Corliss, designed for rope drive.
1—16 x 34 x 48 Hamilton, tandem compound, heavy duty Corliss, designed for rope drive.
6—18 x 36 Allis-Chalmers, heavy duty Corliss.
1—18 x 24 Atlas automatic, four-valve.
1—16 x 42 Allis-Corliss.
1—14 x 30 Hamilton, heavy duty Corliss.
1—16 x 22 Houstod, Stanwood & Gamble, slide valve.
1—14 x 18 Erie City automatic.
1—14 x 16 Brownell, slide valve.
1—13 x 16 Erie City automatic.
1—14 x 12 Erie City automatic.
1—14 x 15 Erie automatic.
1—12 x 16 Chandler & Taylor, slide valve.
1—10 x 12 Chandler & Taylor, slide valve.
1— 9 x 16 Lane & Bodley, slide valve.
1— 9 x 9 Industrial vertical.
1— 8 x 8 Industrial vertical.
1— 6 x 8 horizontal slide valve.
1— 4 x 5 Clark vertical.

BOILERS

3—520-hp. B. & W., A.S.M.E. code, 250 lb. pressure (new).
4—250-hp. B. & W., 150-lb. pressure.
2—250-hp. Sterling, 150-lb. pressure.
4—200-hp., 84 x 18, high pressure return tubular.
4—150-hp., 72 x 18, high pressure, return tubular.
1—140-hp., 78 x 14, high pressure, Ohio standard.
1—125-hp., 72 x 16, high pressure, return tubular.
1—100-hp., 66 x 16 horizontal return tubular.
1—80-hp., 60 x 16, high pressure, Ohio standard.
1—60-hp., 54 x 14, high pressure, return tubular.
1—50-hp., 48 x 14, horizonta lreturn tubular.
3—25-hp., 42 x 95, new, A.S.M.E. code, vertical, 125 lb.
1—15-hp., 36 x 83 new A.S.M.E. code vertical, 100 lb.
1—10-hp., 30 x 83 new Ohio standard vertical, 100 lb.

A. C. MOTORS
3-Phase, 60-Cycle, Squirrel Cage and Slip Ring

No.	Hp.		Make	Volt	Rpm.
6	2	New	Westinghouse	220	1200
4	5	New	G. E.	220	1200
6	7½	New	G. E.	220	1800
10	10	New	G. E.	220	1200
1	10	New	Westinghouse	220	870
6	15	New	G. E.	220	1200
2	15	New	G. E. (slip ring)	220	1200
1	20	Used	Fairbanks-Morse	220	1200
13	20	New	G. E.	220	1200
6	25	New	G. E.	220	1200
2	25	New	G. E. (slip ring)	220	1200
7	30	New	G. E.	220	1200
2	30	New	G. E.	220	900
6	40	New	G. E.	220	1200
2	40	New	G. E.	220	900
3	40	New	G. E.	440	600
2	40	New	G. E. (slip ring)	220	1200
4	50	New	G. E.	220	900
1	60	New	G. E.	220	900
2	50	New	G. E. (slip ring)	220	1200
2	75	New	G. E.	220	900
2	100	New	G. E.	220	900
1	100	Used	Westinghouse	220	1200
1	150	Used	Westinghouse	2200	720
1	250	New	Allis-Chalmers	2200	500

Any of the above 220-volt Motors can be furnished for 440-volt and vice versa.

D. C. GENERATORS
Belted and Direct Connected

1—17½-kw. Triumph, 125-volt, compound wound, D.C. Generator, direct connected to an 8 x 8 Troy vertical automatic Engine.
1—17½-kw. Westinghouse, 125-volt, D.C., compound wound Generator, direct connected to a 7 x 8 Erie Ball, enclosed type automatic engine on sub-base.
1—22½-kw. Allis-Chalmers, 120-volt, D.C., compound wound Generator, 925-r.p.m.
1—50-kw. Allis-Chalmers, 125-volt, 275-r.p.m., D.C., compound wound Generator, direct connected to a Skinner uniflow automatic engine on sub-base.
1—50-kw. Allis-Chalmers, 240-volt, D.C., compound wound Generator, direct connected to a 10 x 12 Erie Ball automatic engine.
1—65-kw. Jantz & Leist, heavy type, 125-volt, compound wound, D.C. Generator, direct connected to a Skinner automatic slide valve engine.
1—75-kw. General Electric, 125-volt, 275-r.p.m., compound wound, D.C. Generator, direct connected to a 14½ x 14 Russell automatic engine on sub-base.
1—100-kw. Triumph, 125-volt, 675-r.p.m., compound wound, belted type Generator.
1—150-kw. Northern Electric Co., 250-volt, D.C., compound wound Generator, direct connected to an 18 x 18 Skinner automatic slide valve engine on sub-base.

A. C. GENERATORS
Belted and Direct Connected

1—800-kw. Allis-Chalmers, 3-phase, 60-cycle, 480-volt Alternator, direct connected to a 26 x 44 x 48 cross compound Allis-Chalmers Corliss Engine.
1—500-kw. General Electric Curtis, vertical, 3-phase, 60-cycle, 2300-volt, 1800-r.p.m. Turbo Generator Set, with Wheeler condenser.
1—375-kva., 3-phase, 60-cycle, 4000, 2000 or 480-volt, 150-r.p.m. Allis-Chalmers Alternator, direct connected to a 21 x 30 Fleming-Harrisburg enclosed type Corliss valve, heavy duty Engine.
2—New 312-kva., 3-phase, 60-cycle, 2300-volt Western Electric Alternators, each direct connected to a new 18 x 24 Corliss Engine.
1—150-kw. Allis-Chalmers, 3-phase, 60-cycle, 2300-volt Alternator, 150-r.p.m., direct connected to a 14 x 30 heavy duty Allis-Chalmers Corliss Engine.
1—125-kw. Ft. Wayne, 3-phase, 60-cycle, 1150-volt, 257-r.p.m. Alternator, direct connected to a 14 x 20½ x 16 Skinner tandem compound automatic slide valve Engine.
1—90-kva. Electric Machinery Co., 3-phase, 60-cycle, 220-volt, 1200-r.p.m. revolving field, belted type Alternator.
1—56.2 kw. Western Electric, 3-phase, 60-cycle, 240-volt, 1200-r.p.m. revolving field, belted type Alternator.

OUR SHOPS AND EXPERIENCE ARE AT YOUR SERVICE

THE RANDLE MACHINERY COMPANY *Established 35 Years*

***Located ONLY at* 1768 POWER ST., CINCINNATI, OHIO**

We have in Stock Motors of any Horse Power, Phase, Speed, or Voltage, in either A. C. or D. C., New or Rebuilt.

Generators: Any K.W. capacity, Belt or Engine Driven, in either D. C. or A. C., any Phase, Speed or Voltage.

We Wish You
A Merry Christmas
and a Prosperous New Year

We are back to pre-war conditions. Motors, generators, pumps, air compressors, boilers, and engines, which you knew were not efficient, but installed to meet war-time emergencies, have no longer a place in your plant. The day of keen competition has arrived, and if your equipment is not such that it will enable you to keep down excessive over-head and meet your competitors' prices, you will lose.

Give this matter serious thought — NOW — before it is too late. Let us know what your conditions are and we shall be glad to offer suggestions to you — it's a part of our service.

The month of December has been for us the BEST month of the year 1920 — the natural result of the excellent service rendered during previous months.

Our business is built on the basis of sound judgment on all advice given and honest dealings — always. We realize that the success of our business rests with our ability to serve you efficiently.

Give us the opportunity during the coming year.

Pumps, Boilers, Air Compressors, Engines, Corliss Slide-Valve or Automatic.

Why not call our engineers at once? It costs you nothing.

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Power Machinery Exchange

1 MONTGOMERY STREET, JERSEY CITY, N. J.

A.C. DIRECT CONNECTED UNITS

375 KVA G. E. 3 ph., 60 cy., 2300 V. alternator with Curtiss horizontal turbine with dir. con. exciter, switchboard and condenser, (seen operating) immediate delivery.
250 KVA Al. Chal., 3 ph., 60 cy., 2300 V. (or 440-220 V.) with Hamilton heavy duty engine, 200 r.p.m.
250 KVA. Al. Chal. 3 ph., 60 cy., 440-220 V. with Buckeye 18 x 30 heavy duty engine, 120 R.P.M.
175 KW Al. Chal. 2 or 3 ph., 60 cy., 2300 V. (or 440-220 V.) with Al. Chal. 16 x 30 heavy duty Corliss engine, 150 R.P.M.
100 KW Al. Chal., 3 ph., 60 cy., 2300 V. (or 440-220 V.) with Erie Ball side crank, 12 x 14 engine.
100 KVA C. W. 2 or 3 ph., 60 cy., 2300 V. (or 440-220 V.) with Ridgway 14 x 12 engine.
90 KVA G. E. 3 ph., 60 cy., 2300 V. (or 440-220 V.) with Chuse Uniflow engine, 14 x 16, side crank, (seen operating).
75 KVA G. E. 3 ph., 60 cy., 2300 V. (or 440-220 V.) with Harrisburg 13 x 14, side crank engine.
60 KVA Elec. Mchy. 3 ph., 60 cy., 2300 V. (or 440-220 V.) with Skinner 11 x 12 engine.

DIRECT CURRENT UNITS

325 KW Wghse. 250-125 volt, with Cooper Corliss engine.
300 KW C.-W. 250 volt, 12 pole, with Watts Cambell cross comp. engine (seen operating).
300 KW, 250 KW, and 200 KW, G. E. 125 volt generators with Fleming 4 valve engines.
200 KW Wghse. 250 volt, 8 pole, with Erie Ball engine.
100 KW Wghse. 125 volt, 8 pole, with Skinner 15 x 16 engine.
75 KW, 60 KW, 50 KW, 40 KW, 30 KW, 25 KW, 20 KW, 15 KW, 10 KW, 7 KW and 2½ KW direct connected units.

STOCK SHIPMENT

DIRECT CURRENT MOTORS—230 Volts

No.	HP.	RPM.	WDG	Type	Make
1	2½	470	cp	CCM	Cr. Wh.
3	4	535/1070	sh	CM	Cr. Wh.
3	4	1070	sh	CM	Cr. Wh.
1	5	1200	sh	MP	Holtzer Cabot
1	5	1650	sh	CE	Gen Elec.
1	5	1850	sh	CM	Cr. Wh.
3	7½	825	sh	CVC	Gen Elec.
1	7½	825	cp	B-7	Milwaukee
3	7½	1150	cp	SK	Westghse
1	7½	1150	sh	MP	Gen Elec.
1	10	635	sh	MP	Gen Elec.
1	10	1700	sh	RC	Gen Elec.
1	15	750	sh	CVC	Gen Elec.
1	15	1170	sh	MP	Gen Elec.
1	20	650	sh		Milwaukee
1	20	1150	sh	RC	Gen Elec.
1	35	720	cp		Lincoln
1	40	720	cp	S	Westghse
1	45	800	sh		Imperial
1	45	600/1200	sh		Northern
2	50	560	cp	CL	Gen Elec.
1	50	400/1200	cp		Westghse
1	55	425/850	sh	DLC	Gen Elec.
1	60	800	cp	MP	Gen Elec.
1	75	680	cp	M	Westghse
1	80	800	sh		Gen Elec.
1	90	1000	cp	A-50	Milwaukee

DIRECT CURRENT GENERATORS—250 Volts

No.	KW	RPM.	WDG	Type	Make
1	11½	1350	sh	MP	Gen Elec.
1	15	1325	sh	RC	Gen Elec.
1	25	850	cp		Lincoln
1	30	725	cp	S	Westghse
1	35	920	sh		Imperial
2	38	650	cp	CL	Gen Elec.
1	45	920	cp	MP	Gen Elec.
1	56	80	cp	M	Westghse
1	60	920	sh	DLC	Gen Elec
1	65	860	cp	M	Westghse
1	70	1150	cp	A-50	Milwaukee
1	85	275	cp	CCD	Cr. Wh.
1	100	850	cp		Thom.-Ryan
1	150	550	cp		Morgan Gard
1	200	500	cp		Northern
1	225	575	cp		Thom.-Ryan

MOTOR GENERATOR SETS

1—25 kw. 250 v. 860 rpm., cp. wd. Lincoln D.C. Generator, direct connected to 1—new Allis-Chalmers 220 or 440 v. 860 rpm., 3 ph. 60 cy. induction motor, complete.

1—45 kw. 500 v. 900 rpm., cp. wd. General Electric D.C. generator direct connected to 1—220 or 440 v. 900 rpm., 3 ph. 60 cy. new Allis-Chalmers induction motor, complete.

1—65 kw. 250 v. 860 rpm., cp. wd. Westinghouse D.C. generator, direct connected to 1—220 or 440 v. 860 rpm., 3 ph. 60 cy. new Allis-Chalmers induction motor, complete.

1—70 kw. 250 v. 860 rpm., cp. wd. General Electric generator, direct connected and mounted on common bed plate with 1/220 or 440 v. 3 ph. 60 cy. new Allis-Chalmers induction motor complete.

1—100 kw. 250 v. 690 rpm., cp. wd. Thomson-Ryan D.C. generator direct connected to 1—Westinghouse 220 or 440 v. 690 rpm., 3 ph. 60 cy. induction motor, complete.

1—150 kw. 125/250 v. 1200 rpm., cp. wd. Westinghouse rotary converter with transformers for 2200 v. high tension, 3 ph. 60 cy. 187 v. low tension, starting taps, complete with starting equipment and switchboard.

1—150 kw. 125/250 v. D.C. 3 wire, Burke Electric motor generator set, consisting of 2—75 kw., 125 v., cp. wd. Burke Generators, belted or chain driven, by 1—new 2200 v. or 440 v. 3 ph. 60 cy. Allis-Chalmers motor, complete.

1—200 kw. 500/550 v. 580 rpm. cp. wd. Westinghouse D.C. generator direct connected and mounted on common base with 1—2200 v. 3 ph. 60 cy. Type CCL Westinghouse induction motor complete with starter and D.C. panel.

1—200 kw. 250/275 v. 900 rpm., cp. wd. Ridgway D.C. generator, direct connected and mounted on common base with 1—2200 v. 3 ph. 60 cy. Ridgway Synchronous motor, complete.

DIRECT CURRENT ENGINE GENERATOR SETS
250 Volts

1—30 kw. 250 v. 800 rpm., cp. wd. Type S Westinghouse D.C. generator belted to 1—Ball Single cylinder horizontal steam engine, 100 lb. steam pressure, 200 rpm., complete with belt pulleys, field rheostat and switchboard panel.

1—35 kw. 250 v. 900 rpm., Imperial D.C. generator belted to 1—Atlas horizontal single cylinder center crank 4 valve steam engine, 11½ x 14, 100 lbs. steam pressure, complete with belts, pulleys, field rheostat and switchboard panel.

1—65 kw. 860 rpm., cp. wd. Type M Westinghouse D.C. generator, belted to 1—Ball horizontal single cylinder slide valve steam engine, 12 x 12, 100 lbs. steam pressure, 250 rpm., complete with belt, pulleys, field rheostat, generator switchboard and all accessories.

1—75 kw. 250 v. 285 rpm., cp. wd. Westinghouse D.C. generator, belted to 1—Lord Howler horizontal single cylinder slide valve steam engine, 125 hp. 220 rpm., 100 to 125 lbs. steam pressure, complete with all accessories, including switchboard.

1—100 Kw. 250 v. 250 rpm. 6 pole General Electric D.C. generator, direct connected and mounted on common bed plate with 1—Erie City Iron Works, horizontal single cylinder side crank slide valve left hand steam engine, 185 hp. 250 rpm. 100 lbs. steam pressure, 17 in. bore 16 in. stroke, complete with all accessories.

1—125 kw. 250 v. 250 rpm. cp wd. Ridgway D.C. generator direct connected and mounted on common bed plate with 1—Ridgway horizontal single cylinder slide valve side crank steam engine, 225 hp. 250 rpm. 16 in. bore, 18 in. stroke, complete with all accessories.

2—250 kw. 250/275 v. 175 rpm. Ridgway D.C. generator, direct connected and mounted on common bed plate with 1—Ridgway horizontal single cylinder single slide valve right hand steam engine, 22 x 24, 100 to 125 lbs. steam pressure, complete with all accessories.

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New and used Electrical Equipment
Electric & Mfg. Co.

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NEW WATER TUBE BOILERS

200 Hp., 225 Hp., 250 Hp.
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Now Available for Immediate Delivery

HEINE—COLVEN—FOSTER and other standard makes

A Stupendous Purchase Just Completed

This big purchase brings us a number of new high grade Water Tube Boilers. All boilers were built under rigid Government supervision and under the inspection of Lloyd's American Bureau and United States Steam Boat Inspection Service.

They are all steel encased and self-contained, requiring a minimum of brickwork and installation cost. Good for 200 lbs. pressure or more.

Adapted to hand firing or stoker application.

Oil burning, coal burning, or gas burning.

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Competent Engineers are ready to serve you and lend their assistance in the installation of your Steam Power Equipment.

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CURTIS IMPULSE STEAM TURBINES

Two Type S, General Electric Company. Ahead and Astern turbine carried on one shaft in the same casing. The ahead turbine developing 2500 H.P. at 3234 R.P.M., when supplied with steam at 200 lb. gage and 50° super-heat at first stage bowl, working against 28½-in. vacuum. Astern turbine developing 1650 H.P. when running at 2050 R.P.M., supplied with steam conditions as mentioned for ahead turbine.

Five Stages in head turbine and two for Reversing unit.

Two Manoeuvering Valves complete, consisting of Duplex Valve with horizontal Spindle, of balance type operated by two levers mechanically interlocking, making it impossible to open but one valve at a time.

Emergency Valve with Steam Strainer.

Guarding Valve for reversing unit.

The above units have been in service less than three years, have been well taken care of and are in excellent condition. Can be inspected and prices quoted at

ATLANTIC REFINING COMPANY
3144 Passyunk Avenue, Philadelphia, Pa.

CORLISS ENGINE GENERATOR UNITS

1—200 K.W. Sprague D.C. Generator 125 volts.
1—250 K.W. Sprague D.C. Generator 125 volts.
1—300 K.W. Sprague D.C. Generator 125 volts.

Each Generator direct connected to Harrisburg 4-valve horizontal Steam Engine, complete equipment with machine panels.

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Immediate Delivery

Westinghouse, Wagner, Allis-Chalmers, Fairbanks-Morse, etc.

Regular Factory Prices. Largest stock of its kind in America.

NATHAN KLEIN & CO., Wholesale Distributors
New York City

Full Diesel Type Oil Engines
Semi-Diesel Oil and Gas Engines
Generators, Air Compressors and Other Equipment
New and Used—All Guaranteed. Various Sizes and Makes. Prompt Delivery.

A. McMILLAN
628 Monadnock Block, Chicago
Specialist in Internal Combustion Engineering

Switchboards

D.C.—Stock Shipment
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All Sizes
Built to Specifications

DUQUESNE ELECTRIC & MANUFACTURING CO.
PITTSBURGH, PA.

exceptionally good values in New and Used Power Equipment

Recent purchases from dismantled munitions plants enable us to offer a wide variety of power machinery and equipment at very low prices.

The following is an abridged list—for prompt shipment.

AIR COMPRESSORS

CG 13 C.—Two steam driven, 11 x 12 x 12 Sullivan air compressors, Type WA-5, capacity 345 cu. ft. per minute, at 220 r.p.m., maximum pressure 120 lbs.

BLOWERS

CG 440 BB. Three No. 8 Beach Russ pressure blowers, capacity 175 cu. ft. per minute at 300 r.p.m. Provided with reverse valve.

BOILERS

TP 1652 D.—Two 100 hp. Vogt boilers, 100 lbs. pressure. Shell 72 in. x 18 ft., 70 4 in. tubes. Butt strapped, double riveted. Safety and stop valves, with of without stack and breechings.

TP 1691 A.—Two 150 hp. B & W water tube boilers, 200 lb. pressure, ½-in. shells, 5/8-in. heads; 63—4-in. x 8-ft. tubes. Catalog fittings. Good operating condition.

TP 897 B.—Two 302 hp. B & W boilers, 150 lb. pressure, 2 drums 42-in. x 20-ft. 2-in. lap joint, double riveted; 144 tubes 4-in. x 18-ft. Set in one battery. Murphy stokers, feed pumps, feed water heaters and piping. 7/16-in. shells. Cast iron headers (9 each).

TP 1690 A.—Four 250 hu. Franklin boilers 150 lb. pressure. Drums 46-in. x 22 ft.; 145 tubes 3½-in. in diameter. 2 sets of breeching connections. Hand fired, shaking grates. catalog fittings.

TP 1662 E.—One 125 hp. Keeler boiler, 125 lbs. pressure, 69 tubes 4 in. x 16 ft. long. Keeler shaking grates. Some retubing necessary.

ENGINES—GAS

TP 1662 J.—One 60 hp. Otto gas engine, 220 r.p.m., two 6 ft. 6 in. flywheels; one 48 x 15 driving pulley. Gas bag, starter consisting of tank, belt-driven air compressor, and pumps.

ENGINES—STEAM

TP 1662 H.—One 50 hp. 10 x 30 Hooven-Owens-Rentchler Co. Corliss engine, flywheel 7 ft. 6 in. x 13 in., 5 ft. belt pulley. Immediate fittings and canvas belt. Good operating condition.

TURBO GENERATOR SET

TP 1690 E.—One 300 kw. 3 ph., 60 cy., 480 volt Kerr-Allis-Chalmers turbo generator set 6-ft. 6-in. x 20-ft. 9-in. marble switchboard equipped with ammeter, voltmeter, rheostat, switch and circuit breaker.

Write us for "TP" ECONOMIST Power Section.

TECHNICAL PRODUCTS COMPANY
INCORPORATED
CHICAGO 501 FIFTH AVENUE, NEW YORK TORONTO

AIR COMPRESSORS

Steam Driven

100 LBS. PRESSURE

1700 cu. ft. 16-in. and 28-in. x 25-in. and 15-in. x 20-in. Ingersoll-Rand, Imperial type 10, compound Corliss steam cylinders, 2 stage air.

1333 cu. ft. 22-in. x 22¼-in. and 15¼-in. x 24-in. Ingersoll-Rand straight line, 2 stage air.

385 cu. ft. 14-in. x 14-in. x 14-in. Chicago Pneumatic Tool Co., straight line.

374 cu. ft. 14-in. x 9-in. x 12-in. Ingersoll-Rand, duplex two stage.

262 cu. ft. 11-in. x 12-in. and 7-in. x 10-in. Clayton straight line two stage for 100 lbs.

210 cu. ft. 8-in. x 14-in. and 8-in. x 10-in. Clayton duplex two stage for 100 lbs.

260 cu. ft. 12-in. x 12-in. x 16-in. Ingersoll-Rand.

233 cu. ft. 12-in. x 12-in. x 12-in. Platt Iron Works.

135 cu. ft. 10-in. x 10-in. x 10-in. Ingersoll-Sargent.

30 cu. ft. 9½-in. x 7-in. x 10-in. Westinghouse.

LOW PRESSURE

924 cu. ft. 14-in. x 22¼-in. x 18-in. Ingersoll-Sargent, straight line, pressure 10 to 25 lbs.

700 cu. ft. 10-in. and 18-in. x 14-in. x 14-in. Laidlaw-Dunn-Gordon, compound steam, duplex air, for 50 lbs. pressure.

305 cu. ft. 10-in. x 14-in. x 10-in. American, straight line, for 45 lbs. pressure.

200 cu. ft. 8-in. x 14-in. x 8-in. Clayton, straight line, for 30 lbs. pressure.

80 cu. ft. 10-in. x 14-in. x 12-in. Snyder Hughes, direct acting air pump for 20 lbs. pressure .

6½-in. x 8½-in. x 10-in. Foster.

Belted Air Compressors also for sale up to 1000 cu. ft. Suitable electric motors also in stock.

Wickes Machinery Co.
Jersey City, N. J.

NEW BOILER FEED PUMPS

2—Turbine driven centrifugal pumping units designed for 200 lb. pressure consisting of:

4 in., 4 stage centrifugal pumps direct connected to 100 hp. steam turbines. New apparatus, never used.

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FOR SALE

CORLISS ENGINE

325 H.P., extra heavy duty. Excellent condition. Can be seen operating. Big bargain if taken at once.

LE ROY LIME & CRUSHED STONE CORPORATION
Le Roy, New York

1—Dean of Holoyke

UNDERWRITERS PUMP

No. 22736. Size 16-9-12
Capacity 750 gals per min.
Speed 70 R.P.M
50 lbs. steam pressure, $19.20

F. C. HUYCK & SONS
Albany, N. Y.

2—156 Kva. Eng. Sets
240-480 v., 60 cy., 3 ph.—
14¼ x 18 ENGS.

2—375 Kva. Eng. Sets
60 cy., 3 ph., 2300 v.—25 x 24 ENGS.

ROSS POWER EQUIP. CO.
Indianapolis, Ind.

ENGINES
10 to 150 hp. Slide Valve.
14 x 30 Watts Campbell Corliss.
18 x 42 Knowlson & Kelly Corliss.
18 x 48 Harris Corliss.

BOILERS
25 hp. Erie City Economic.
10 to 60 hp. Vertical.
66 x 18 H.R.T., 125 lbs.
3—72 x 18 H.R.T., 100 lbs.
250 hp. Scott Marine, 150 lbs.
2—130 hp. B. & W. Sterling.
1—250 hp. B. & W. Sterling.

MISCELLANEOUS
30-in., 42-in. 60-in. diameter STACKS.
1—8 x 6 x 9 Westinghouse Compressor.
75 kw. D.C. Generating Unit.
25 kw. D.C. Generating Unit.
4—2½ kw. Engberg D.C. Unit.

Tanks, Pumps, Feed Water Heaters, etc. Write me your requirements.

SAMUEL C. MORRIS
1133 Broadway, New York City.

FOR SALE—1 Warren

STEAM PUMP

built by Warren Steam Pump Co., Warren, Mass., Size 14-in. x 20-in. x 10½-in. x 18-in., Horizontal duplex compound type, packed pistons full brass fitted throughout. 150 lbs., water pressure, 125 lbs. steam pressure, brand new just as received from factory, never been erected.

Ready for immediate shipment. Reasonably priced.

Address E. H. Kearney, Supt.
Massachusetts Trust Associates
Boston, Mass.

20 x 42 CORLISS ENGINE

Fishkill, left-hand Engine. Wheel is 14 ft. x 26 in. First class order. All fittings complete. This is a **BARGAIN.**

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P. O. Drawer 45, Syracuse, N. Y.

Ready to Ship—Just Taken Out of Service

Two—400 h.p. B & W WATER TUBE BOILERS

Complete with all fixtures and fittings. Operated at 150 lb. pressure. In excellent condition. Hand fired.

One—400 h.p. Heine-Type WATER TUBE BOILER

3 yrs. old. Built for 175 lb. pressure. A.S.M.E. construction. Complete with Green Chain Grate Stoker.

Send Us Your Requirements For Power Plant Equipment.

The Markman Engineering Company, 111 W. Monroe St., Chicago

Serviceable Used

MACHINERY

STEAM ENGINES

1—Knowlson-Kelly Corliss Cross Compound 16 x 30 x 36. Complete with pumps and condensers.
1—70 Hp. Center Crank Engine complete with Governor and all fixtures.
2—25 Hp. steam engines.

BOILERS

1—150 Hp. Franklin H. R. T. Boiler, with fronts, shaking grates and all fixtures, 125 lb. pressure.
1—250-hp. Pinkerton H.R.T. Boiler, with fronts, shaking grates and all fixtures, 125-lb. pressure.
1—80 Hp. Erie H. R. T. Boiler, with all fixtures, 115 lb. pressure.

AIR COMPRESSORS

1—Foster, 8½ x 12, two stage chain driven air compressor.
1—Blake, 8 x 10 single stage steam air compressor.

AIR TANKS

2—Steel air tanks, 36-in. x 15-ft.
1—Steel air tank, 48-in. x 9-ft.
1—Steel air tank, 30-in. x 7 ft. 6 in.

STEAM PUMPS

1—Knowles Duplex Steam Pump, 10 x 6 x 12, 5-in. suction.
1—Snow Duplex Steam Pump, 6 x 4 x 6, 3-in. suction, 2-in. discharge.
1—Knowles Duplex Steam Pump, 6 x 4 x 6, 3-in. suction, 2-in. discharge.

UNIVERSAL MACHINERY CO.
74 Chapel Street, Albany, N. Y.
Tel. Main 4541.

FOR SALE

1—380 hp. hand-fired Stirling Water Tube

BOILER

334—tubes, 3¾-in. dia., guaranteed for 100 lb. steam pressure, complete with all fittings. Excellent condition.

Duquesne Electric & Mfg. Co.
Pittsburgh, Pa.

BOILERS, TUBES, TANKS

2—Erie City Watertube, 400 hp. each.
1—Mass. Standard 72-in. x 17-ft. 6-in. H. R. T., 125 lb. pressure.
4—Manning Vertical Boilers, 500 hp., will insure for 175 lbs. Immediate delivery.

Many Other Boilers

Second-hand Pipe, Boiler Tubes, Tanks, Relaying Rails, Beams.
50 Tons second-hand 2-in. Loco. Tubes.
1—1500 hp. Berryman Feed Water Heater.
1—1300 hp. George F. Blake Heater.
16—7 x 10 double drum Stroudsburg Engines fitted with link motion. Drums 24-in. x 24-in. with rear one having concave ends for transversing line.
125,000 ft. of ⅝-in., 1⅜-in. and 1¼-in. Wire Cable.
500 tons of 6 in., 12¼ lb. Steel Beams, 15 ft. 9 in. long.
100 tons of 5 in. Bethlehem H Beams, 15-25 ft. long, 18 lbs. per ft.

THE PERRY, BUXTON, DOANE CO.
214 W. First St., South Boston, Mass.

BOILERS

3—266 H.P. each KEELER Horizontal Water Tube Boilers. Butt Strap, Triple Riveted Drums, 160 lbs. pressure.

Immediate Delivery

Other power plant equipment in stock including Engines, Compressors and Boilers

CASTLE & WILSON
1601 Arrott Bldg., Pittsburgh, Pa.

BOILERS

We offer subject to prior sale the following used boilers:

10—B & W 275 hp., 125 lb. pressure.

12—Sotter Bros. 140 hp., return tubular, 90 lb. pressure.

Chief Engineer's Office
National Sugar Refining Co. of N. J.
Yonkers, N. Y. (U. S. A.)

BOILERS

1—508 Hp. B. & W. Steel, header 180 lbs.
2—300 Hp. B. & W. Steel, header 180 lbs.
2—200 Hp. B. & W. Steel, header 180 lbs.
2—110 Hp. B. & W. Steel, header 150 lbs.

GENERATOR SETS

2—120 Kw. Westinghouse 125 volt D.C. Westinghouse compound engines.
2—100 Kw. Westinghouse 125 volt D.C. Westinghouse compound engines.

FEED WATER HEATERS

1—1,000 Hp. Feed Water Heater.

ICE MACHINE

1—60-ton Horizontal Westinghouse Ice Machine. Corliss Engine driven.

CONSOLIDATED MACHINERY & WRECKING CO.
110 W. 40th St., New York City

FOR SALE

Water Tube Boilers

6—300 hp. Vertical Wickes Steel Casing now operating at 150 lb. steam pressure. Equipped with Wright Water Column, Crane Automatic Stop and Check Valves. McDonough Expansion feed water regulators. 2 Boilers have Lunkenheimer Duro Blow-off Valves, 4 Boilers have Powell Y Blow-off Valves.

Stokers

6—Detroit V type

size 7 x 7. Equipped with one stoker engine and one motor. Arranged to drive all stokers with engine or motor. Three can be ready for shipment between Dec. 1st and Jan. 1st. Balance to follow quickly as possible.

This equipment is in A-1 condition and can be seen in actual operation at any time.

KING PAPER CO.
Kalamazoo, Michigan

FOR SALE

All in first class condition

GENERATOR

1—General Electric D.C. Type M.P. 110-115 Volt 520 Amp. 805 r.p.m with field Rheostat and Rails.

MOTORS

1—D.C. Watson 2½ Hp., 19 Amp., 110-115 Volts, 930 r.p.m. complete with starter and rails.

1—Crocker-Wheeler 5 Hp. D.C., 110-115 Volts, 960 r.p.m., 5 Hp., 38 Amp. Complete with starter and rails.

HUTTIG MANUFACTURING CO.
Muscatine, Iowa, U. S. A.

FOR SALE

1—367 Hp. Heine, double butt strapped,

BOILER

160 lbs. pressure.
Immediate Delivery — Excellent Condition

R. B. HOBSON
120 Broadway, New York City

COMPLETE PLANTS BOUGHT AND SOLD

(IN STOCK NOVEMBER 20th)

WE HAVE FOR IMMEDIATE DELIVERY

MOTORS

3-PHASE, 220/440 V.

1—250 hp. NEW Crocker Wheeler 600 r.p.m. Slip Ring.
2—30 hp. Westinghouse 1200 r.p.m.
1—20 hp. Westinghouse 900 r.p.m.
2—200 hp. Westinghouse, sq. cage, 580 and 870 r.p.m.
2—100 hp. Crocker-Wheeler, 1800 r.p.m.
3—50 hp., 720 r.p.m. Fairbanks-Morse
2—50 hp., Triumph 900 r.p.m.
2—30 hp., Cleveland, 900 r.p.m.
2—25 hp., 900 r.p.m. Allis-Chalmers.

2-PHASE, 220/440 V.

1—200 hp., 580 r.p.m. Westinghouse, Type C.
1—200 hp., 870 r.p.m.

1-PHASE, 110/220 V.

2—1/6 hp. Century, 1165 r.p.m.
10—¼ hp., 1750 r.p.m. Robbins & Myers.
20—¼ hp., 1725 r.p.m. Westinghouse.
2—1½ hp. Century, 1165 r.p.m.
3—2 hp. Wagner, 1750 r.p.m.
3—3 hp. Wagner, 1750 r.p.m.
2—3½ hp. Century, 1165 r.p.m.
1—7½ hp. Wagner, 1140 r.p.m. 220 volt.

MOTOR GENERATOR SETS

1—40 Kw., 250-v. Westinghouse Generator, 1200 r.p.m., and 60 hp. Westinghouse synchronous motor, with switchboard and starting equipment.
1—100 Kw., 250-v. Westinghouse, to 150 hp. Westinghouse, Type C, 220-v., squirrel cage motor.
1—150 Kw. Westinghouse 250 v. to 225 hp. Westinghouse 2200 volt Synchronous Motor. Exciter and switchboard (new).

DIRECT CONNECTED SETS

1—100 Kw., 250 V. Ft. Wayne-Russell.
1—75 Kw. Westinghouse, 125-v., D.C. to Erie Ball latest enclosed engines, piping, parts, etc.
1—30 Kw., 125-v., Western Electric, to Buckeye piston valve engine.
1—150 Kw., 250-v., D.C. Gen. Elec. Turbo-Generator unit, 140 lb. non-condensing.
Also larger units.

ELECTRIC HOISTS—NEW

5—15 hp., 230-v., D.C. double drum, side by side with 12 x 12 drums, to carry 6000 ft. ½-in. rope each.

TANKS

5—3000 gallon—¾ steel.
3—5000 gallon—⅜ steel.

Send for complete list

W. A. CARRELL & CO., 211-213-215 Second Avenue, Pittsburgh, Pa.

Must Move At Once

The 75 K.W., D.C. Busch-Sulzer Westinghouse oil engine unit which is now in our plant.

Construction has reached a point where we must dismantle the machine and take it from the engine room.

It is still in operating condition. Come and inspect it while you can.

No definite price on the machine. Make us an offer after you see it.

INTERNATIONAL TIME RECORDING CO.
Endicott, N. Y.

READY FOR
IMMEDIATE SHIPMENT

COMPRESSORS
1—Sullivan W.J.-3, 20 x 12 x 14 in. belt driven, 1145 cu. ft. Angle compound.
1—Ingersoll-Rand, belt driven, 900 cu. ft.

GENERATING SETS
Several D.C. and A.C.

BOILERS—(H.R.T.)
2—54-in. x 12-ft. Phoenix with stacks.

(WATER TUBE)
1—150-hp. B. & W., 150-lb.
1—309-hp. Stirling, 160-lb.
2—115 hp. B. & W. Mass. Std. 160 lb.

OIL ENGINES
1—28-hp. De La Vergne, type HA.
1—60 hp. De La Vergne, Type D.H.
1—100-hp. American Diesel, 16-in. x 24-in.
1—100-hp. De La Vergne, type FH.
1—200-hp. De La Vergne, type FH.
2—225-hp. Busch Diesel, 3 cyl.

GAS ENGINES
1—190-hp. Rathbun-Jones, three-cylinder.

TANKS OF ALL SIZES

Refrigerating Machinery and Equipment.

Send for our Thrift Book which contains complete list.

WRITE—PHONE—WIRE

MACHINERY UTILITIES CO., Inc.
501 Fifth Ave., New York, N. Y.
Vanderbilt 2752

This company is not interested in or connected with any other used machinery concern.

ALTERNATING CURRENT TURBO UNIT

1—100 Kva. Crocker Wheeler three phase, 60 cycle, 220 volt alternating current, consisting of two 50 Kva. generators, direct connected to a De Laval Turbine, 125 lbs. pressure, 1200 r.p.m.

HORIZONTAL AND LOCOMOTIVE BOILERS

1—250 hp. Tippet and Wood H.R.T. Boiler, 84-in. x 22-ft., 110 lb. steam working pressure.
1—150 hp. Erie City Iron Works H.R.T. Boiler, 125 lb. steam working pressure.
1—100 hp. Ames Iron Works Locomotive Return Tubular Boiler, portable type, 125 lb. steam working pressure.
1—70 hp. Ames Iron Works Locomotive Tubular Boiler, 110 lb. steam working pressure.

VERTICAL BOILERS—NEW

A.S.M.E. Code.
"Full-Length Tube."
For 100 pounds Working Pressure.

60	hp.	54-in. x 10-ft.	25	hp.	42-in. x 8-ft.
50	hp.	48-in. x 11-ft.	20	hp.	36-in. x 8-ft.
45	hp.	48-in. x 10-ft.	18	hp.	36-in. x 7-ft.
40	hp.	48-in. x 9-ft.	15	hp.	36-in. x 6-ft.
35	hp.	42-in. x 10-ft.	12	hp.	30-in. x 7-ft.
30	hp.	42-in. x 9-ft.	10	hp.	30-in. x 6-ft.

BELT DRIVEN AIR COMPRESSORS

1—New Nagle 20 and 12 x 12, 2-stage, 960 cu. ft. capacity.
1—10 x 8 Blaisdell, enclosed case, 170 cu. ft. capacity.

110-VOLT DIRECT CONNECTED UNIT

1—100 kw. Crocker Wheeler 110-125 volt, compound wound, 8-pole D.C. Generator, direct connected to a 14-in. x 21-in. Hamilton Corliss Engine.

A. C. DIRECT CONNECTED SET

1—175 Kva. General Electric two phase, 60 cycle, A.C. revolving field Alternator, direct connected to a Skinner uniflow Horizontal Engine 225 r.p.m.

AIR COMPRESSORS—STEAM DRIVEN

1—10 x 10 x 10 Nagle Corliss Engine, Type "B," 145 cu. ft. capacity.
1—10 x 10 x 10 American, 140 cu. ft. capacity.
1—10 x 10 x 10 Hall Steam Pump Company, 150 cu. ft. capacity.
1—6-in. x 6-in. x 6-in. Nagle Corliss Engine, Type "B," 35 cu. ft. capacity. New.

FRANK TOOMEY, 127-131 North Third Street, Philadelphia

Here's the best sales-story yet!!

A certain big company had an electric generator lying around its plant for about two years. During that time letter after letter was sent to its numerous branch offices asking if any of them could use it. Finally the company decided to run a "blind" ad in the Searchlight Section—and a few days later got a wire for the machine from one of its own branch houses.

What direct personal letters did not accomplish in *two years*, "Searchlight" advertising did in *two weeks!* Maybe "Searchlight" appeared at the psychological moment but—

These facts are evident: "Searchlight" is so well known and has such a complete circulation that it can be depended upon to find buyers wherever they may be—even among the owners' branch offices.

For Every Business Want
"Think* SEARCHLIGHT *First"

SEARCHLIGHT SECTION

We have for sale and ready for immediate shipment in first class condition the following equipment.

1—45 H.P. Marine type boiler. Butt strapped double riveted complete with all fittings and stack.
1—72 x 18 HRT Brownell boiler. Double riveted butt strapped constructed complete with fronts and fittings.
1—Erie City HRT 72 x 18 Butt strapped double riveted complete with full flush fronts and all necessary fittings.
3—30 HP. fire box boilers butt strapped complete with all fittings.
3—200 HP. Gary water tube boilers, butt strapped double riveted 150 lb. steam pressure for re-installation complete with all fittings and fronts.
1—125 HP. Marine type boiler, corrugated fire box complete with all necessary fittings.
2—12 x 10 x 18 Laidlaw Dunn Gordon steam pumps.
2—7½ x 4½ x 10 Worthington steam pumps.
2—500 HP. Corliss heavy duty stationary engines.
1—Deming triples belt driven pump.
1—400 HP. Cochran water feed heater closed type.
1—800 foot Ingersoll-Rand Air Compressor.
1—10 x 12 J.B. Alfree horizontal center crank engine.
1—40 HP. Erie center crank horizontal steam engine.

We also have several upright boilers that are ready for immediate shipment.
Write, wire or phone to us for prices and specifications.

The Central Machinery & Equipment Inspection Bureau
343 Spitzer Building, Toledo, Ohio.
Yards and Warehouse, York and Wheeling Streets
Bell Phone Main 5344 Home Phone Main 1757W

POWER!

1—208 hp. B. & W. type Boiler, 160 lb. pressure.

2—PORTABLE Boilers, Economic type, 1—100 hp. and 1—60 hp., complete with Stacks and fittings.

8—Feedwater Heaters, 50 to 2500 hp.

1—150 k.v.a. Alternator used two months.

2—150 k.v.a. SEMI-DIESEL OIL Engine Units, Direct Connected.

14—265 kw. Transformers.

1—30 cu. ft. Air Compressor.

1—Large Main Belt.

Engine Generator Units, A.C. and D.C. Large Stock of Corliss Engines, Belted and Direct Connected.

Complete Power Plants Designed and Erected. Your Inquiries solicited.

POWER EQUIPMENT CO.
Engrs.,
1809 Buttonwood St., Philadelphia

IMMEDIATE DELIVERY!

BRAND NEW

HEWES & PHILLIPS CORLISS

STEAM ENGINES

with manufacturer's guarantee at attractive prices

4—14 x 30-135 H.P.
1—14 x 36-150 H.P.
1—16 x 36-200 H.P.
} Designed for Belt Drive

1—16 x 24 Heavy duty designed for direct connection to type TRE 192 K.W., 164 R.P.M. 3 Phase, 60 Cycle, Sprague Elec. A. C. Generator.

ESSEX ENGINE & MACHINE CORPORATION
Newark, N. J.
Successors to
Hewes & Phillips Iron Works

NEW
TRANSMISSION EQUIPMENT

25% Below Market

95% Packed in Original Wrappings

consisting of

Transmission Machinery, Pulleys, Hangers, Ring Oilers, Wooden Tanks, Archer and Garlock Packing, Engineers Oil Cans, Grease Cups, Lubricators, Injectors, Chisels, Screw Drivers, Repair Parts of Edgemoor Boilers, Wrenches, Steel Cable, Etc., Etc.

Send for Detailed List with Prices

NATIONAL PIPE & SUPPLY CO.
907 Liberty Bldg., Philadelphia, Pa.

IMMEDIATE DELIVERY

60 CY. 3 PH. ENG. SETS, ETC.

2—156 Kva. 240-480 V., Engs. 14¼ x 18.
375 Kva. 2300 V., G. E. 25 x 24, 150 Rev. Eng.
300 Kva. 240-480 V., 40 Cy., 3 Ph., G. E. Cor. Eng.
1000 Kva. 2300-480 V., cross Comp. Cor. Allis.
150 Kva. 2300 V., cross Comp., 4 valve Chuse.
625 Kva. 2300-480 V., G. E. cross Comp.
750 Kva. NEW, 164 r.p.m., Gen. only.
175 Kva. 220 V., Westg. 17 x 15 engine.
937 Kva. 2300 V., 164 rpm. G. E. Lentz, C. Comp.
1000 Kva. 2300-480 V., 90 Rev. Gen. only.
NEW 475 Kva. OIL ENGINE SET, 600 V., 3 Ph., G. E.

3 PH. A. C. MOTORS, D. C., ETC.

NEW 750 hp., 180 r.p.m., 2200 V., mill type.
400 hp. 112 Rev., 2200 V., 25 Cy.
200 hp. 1800 Rev., 440 V., G. E.
150 hp. 850 Rev., 2300 V.
400 hp. Syn., 720 Rev., 2300 V.
400 hp. G. E., 2200 V., 720 Rev.
300 hp. 440 V., Allis, 600 Rev.
NEW 350 hp. 600 Rev., 3 bearing, 440 V.
2—700 Kva., 25 Cy., Syn. condensers.
NEW 468 hp., 187½ Rev., 2200 V., 25 Cy., Syn.
200 hp. 350 Rev., 500 V., Dir. Cur. G. E.
150 hp. 750 Rev., 230 V., G. E. Dir. Cur.
200 hp. 300 Rev., 115 V., Dir. Cur.
250 hp. 130 Rev., 250 V., Dir. Cur.
500 hp. 260 Rev., 500 V., Dir. Cur.

ROTARIES & M. G. SETS, ETC.

5—300 Kw. Ry. rotaries, 25 Cy., 3 Ph., 15,000 V. Trans.
400 Kw. Ry. rotary, 3 Ph., 60 Cy., 4600 V. Trans.
400 Kw. 275 V., 60 Cy., rotary, 4000 V. Trans.
1000 Kw. 250 V., M. G. set, 6600-4000 V. A.C.
640 Kw. 50 Cy., 3 Ph., A.C., 550 V., D.C.M.G.
NEW 10 and 15 Kw., 125 V., TURBO EXCITERS.
587 hp. RUST TYPE B. & W. BOILERS, 175 lb.
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1600 ft. Wheeler surface cond. and auxls.
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30—Air compressors steam and belt drive, steam vacuum and centrifugal pumps, rock crushing plants, gas engines, etc.

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1—Stack, 130 ft. high x 72 in. diam.
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1—Stack, 90 ft. 0 in. high x 48 in. diam.
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Complete with all accessories, can also furnish electric motor for same.

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1	7½	220 or 440	1200	Western Electric, KT, new, 50 deg.
1	7½	220	1800	Roth, new, 40 deg.
1	7½	220	1800	Lincoln, new, 40 deg.
3	10	220 or 440	1800	Western Electric, KT, new, 50 deg.
1	10	220 or 440	1200	Western Electric, KT, new, 50 deg.
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THE accuracy and high efficiency in reducing steam, air or gas pressure obtained with Mason Standard Reducing Valves is the result of nearly 39 years' experience in their making. Designed by engineers to establish the most economical operating conditions in the plant with the minimum in attention or repairs. Guaranteed for any initial pressure up to 300 lb. which they will bring down in a single reduction to any pressure above 5 lb. with a pressure difference of only 10 lb. to operate them.

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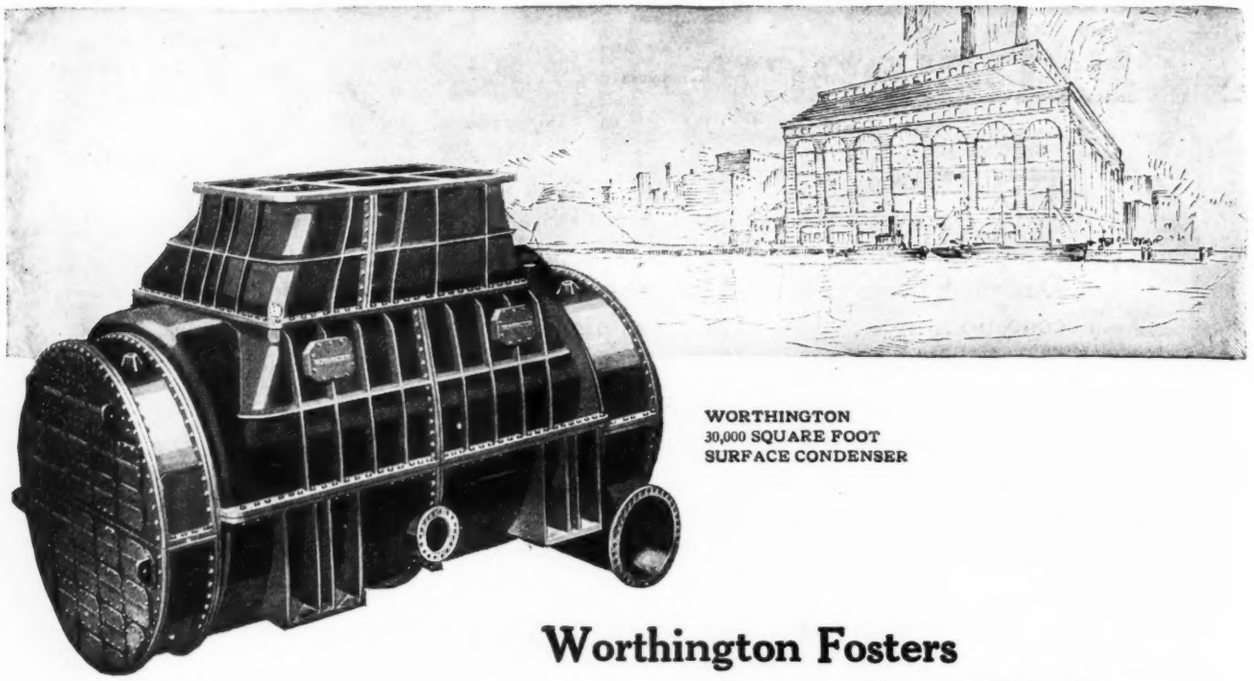

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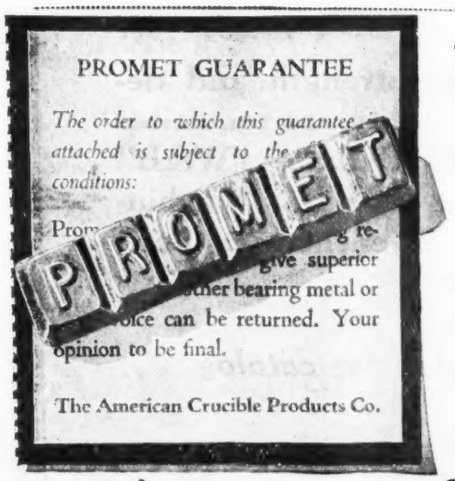
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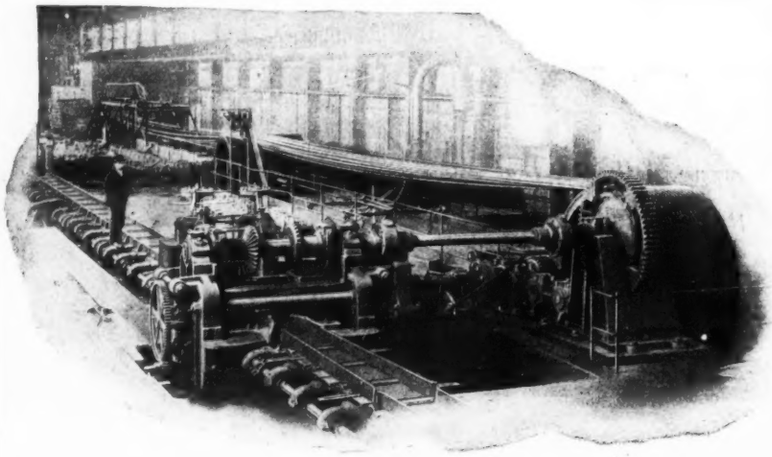

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hold tight under any pressure up to 250 lbs. and will not buckle, cut, flow, stick, jam or rust under heaviest expansion. Howard Guided Expansion Joints will make 1921 happier and more prosperous.

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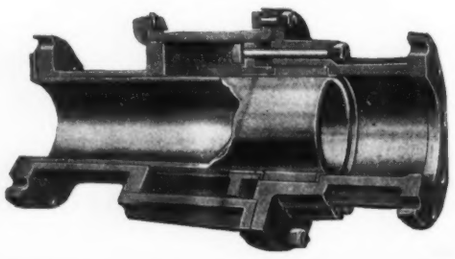

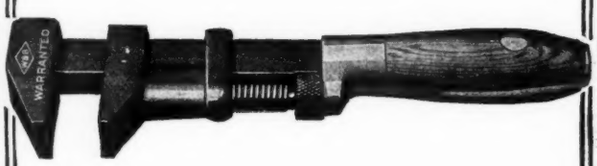

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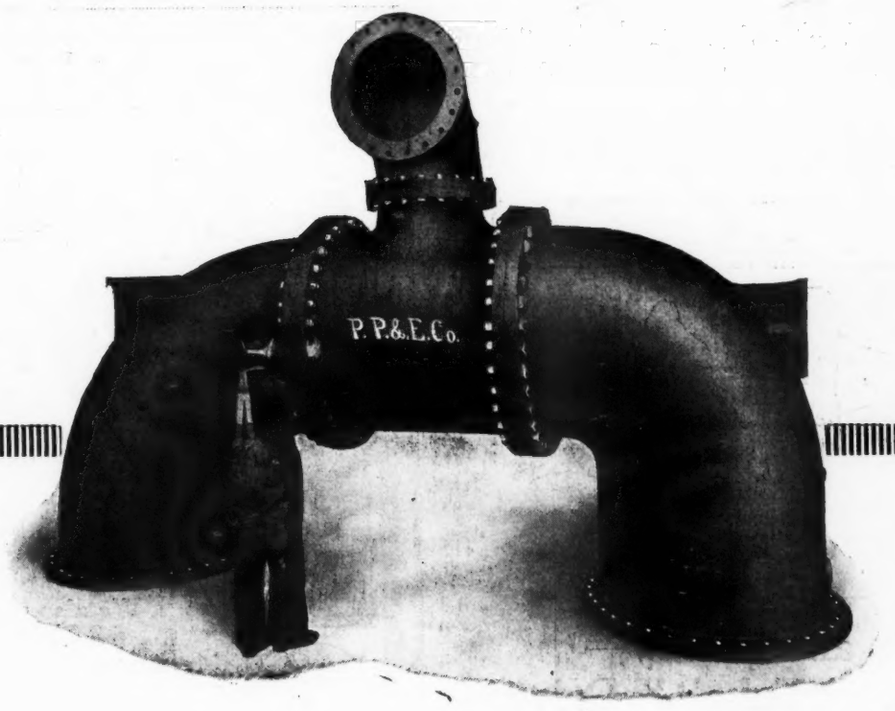

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Toledo Power Drive for Toledo Pipe Tools

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TOLEDO Portable Power DRIVE

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Manufacturers of "Toledo" Pipe Tools

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WONDER "Bending Machines"

Bend Pipe Cold

Eliminate Friction

3 New Models

"Wonder" Pipe and Tube Bending Machines (pat.) electrically operated to bend from 1 in. to 18 in.

We also manufacture 10 OTHER SIZES

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Straight or Bent **For All Types of Boilers**

Pipe Bends, Conduit Elbows

THE AMERICAN TUBE & PIPE BENDING CO.

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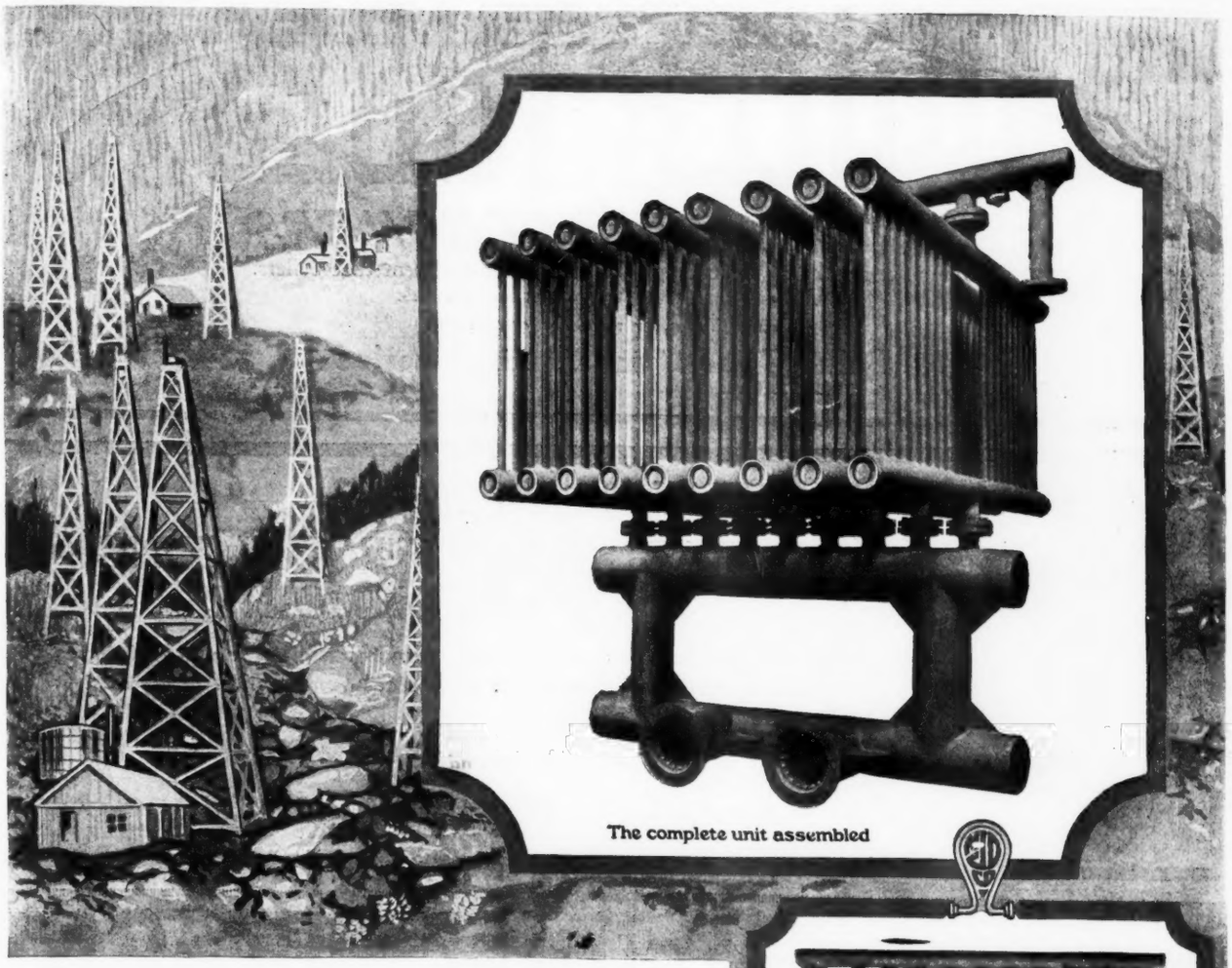

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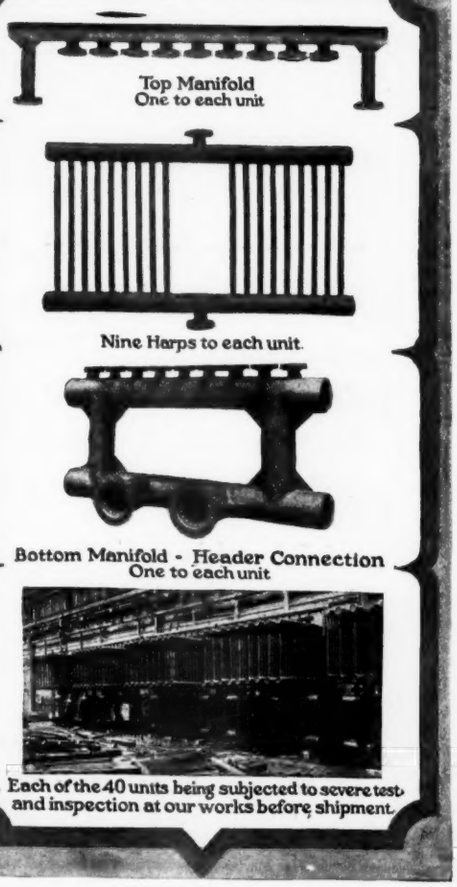
OUR LINE Includes Pipe, Pipe Lines Welded Pipe Headers Lap-weld, Fittings Cast, Fabricated Pipe Work of every description, Joints Flanged and the M.J.D. Square Lap Joint



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Also carry a large stock of straight tubes.

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FEATURES

Location of brass seat ring away from pipe contents and all other harmful influences. Prevents the possibility of injury to the seat ring from pipe ends. A patented feature.
Ground ball brass-to-iron joint, ground with mate and never separated.
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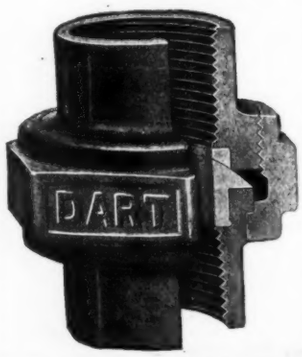

wherever they have been installed—and that is the principal reason for the wide distribution of

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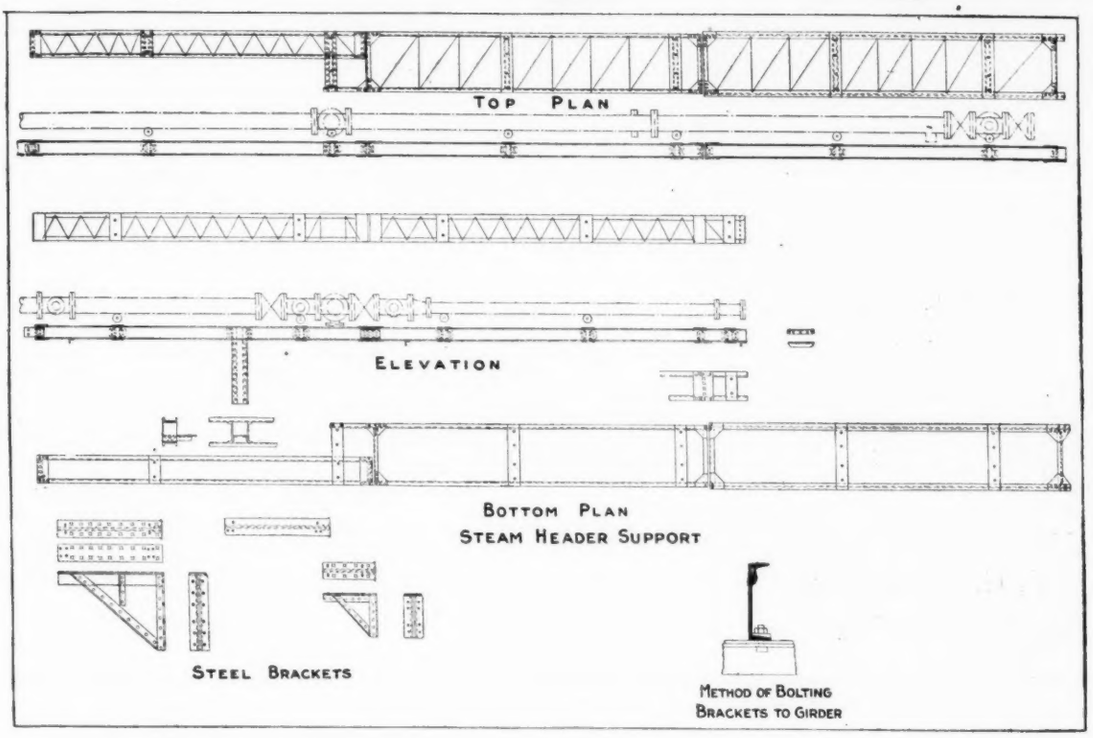
E. M. Dart Mfg. Co.
Providence, R. I.

The Fairbanks Company, Sales Agents. Canadian Factory: Dart Union Co., Ltd., Toronto.

Our Piping Work Is Done On A Sound Engineering Basis



Careful analysis of both the operating and the structural requirements by piping specialists, before the final plans are made, eliminates many delays that are so frequently encountered in the erection of the work in the field.

When necessary we have designed heavy structural steel girders to support large steam headers to insure the maximum safety and rigidity for anchorage.

Our work has included the piping of some of the largest Central Stations, Steel Mills, and Manufacturing Plants, covering a wide range of industries. We have modernized old piping systems that have resulted in very material savings in operating cost to the purchaser.

No job is too large or too small to receive our careful attention. Consultation on special piping problems are invited. We make no charge for this service, nor is a prospective customer obligated in any way in obtaining recommendations and cost estimates from us.

We do work on a lump sum contract basis under protecting guarantee to the customer, for the complete piping job. Or, if preferred we will furnish materials only to blueprints and specifications.

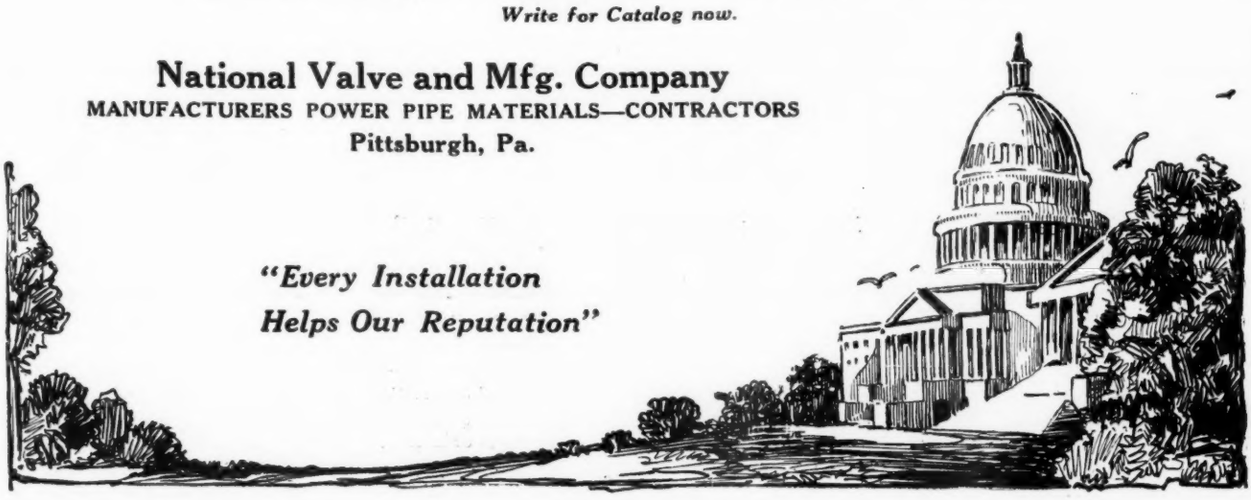
We furnish Pipe, Pipe Bends, Offsets, Flanges, Fittings, National Lap Joints, Welded Headers, Valves, Special Castings and Fabricated Pipe Work of every description.

Write for Catalog now.

National Valve and Mfg. Company

MANUFACTURERS POWER PIPE MATERIALS—CONTRACTORS

Pittsburgh, Pa.



"Every Installation Helps Our Reputation"

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Compressed Asbestos Packing

Increase the efficiency of your plant

YOU can stop the leaks, squeeze-outs, burn-outs and blow-outs once and for all, by the exclusive use of TENAX.

It is the **safe** packing for your high and low pressure saturated and superheated steam, gas engine, ammonia, oil, alkaline, hot and cold water joints.

Make every joint 100% *efficient with TENAX. Ask your jobber, or write direct for prices.*

The Original Blue Sheet

Advance Packing & Supply Co.

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Allied Industries, Inc., Pacific Coast Representatives: 283 Minna St., San Francisco, Calif.; 340 Azusa St., Los Angeles, Calif.; 1252 First Ave., So., Seattle, Wash.

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Chas. A. Schieren Company

Tanners and Belt Manufacturers
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DUXBAK Waterproof Leather Belting

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"SAFETY" PLASTIC
METALLIC PACKING
For Steam, Water, Air, Gas, etc.
GUARANTEED TO LAST THREE YEARS
Without Renewal
Drop us a line and let us tell you all about this Remarkable Packing
Steel Mill Packing Co., Established 1899 Detroit, Michigan

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TUBES, SHEETS,
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Save your oil—save your engine—save your machinery and save your money by writing *today* for our 200-page catalogue.

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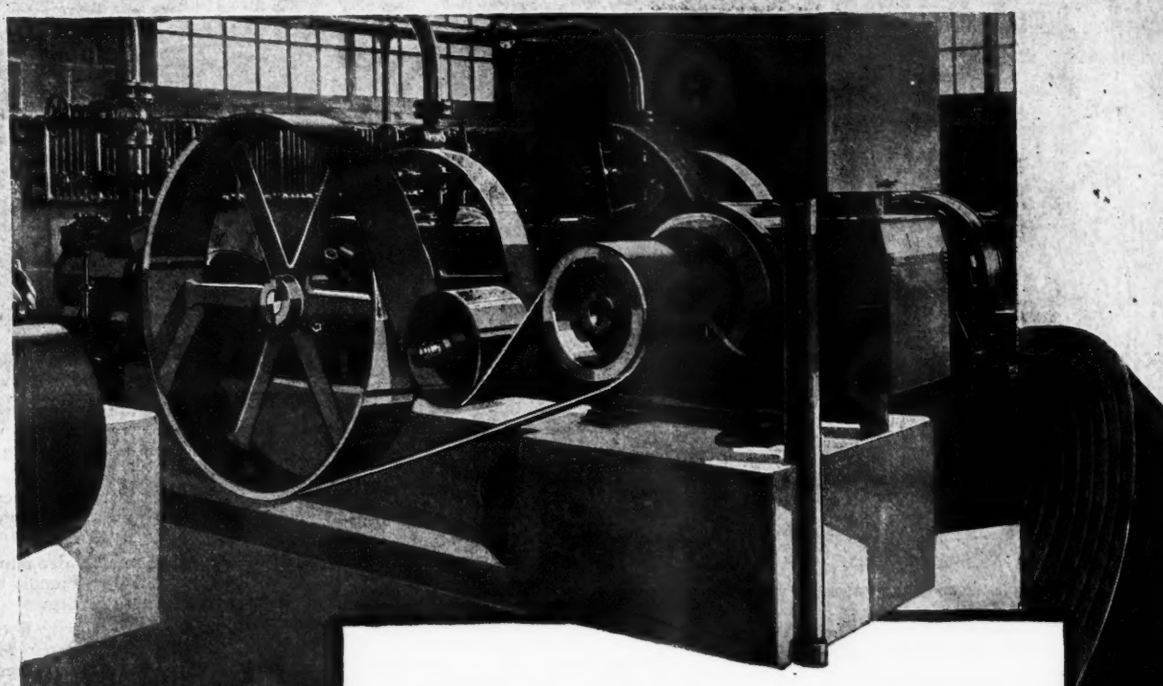
150-152 W. Superior St., Chicago, Ill., U. S. A.
Established 1897



Every belt buyer pays for his belting on the instalment plan.

His cash deposit, in the form of the purchase price, gives him possession.

Follows, then, a series of payments on account—in the form of repair costs, lost time, reduced output.

And full payment is not made until the belt is worn out.

"HOYT'S" LEATHER BELT because of its time-proof qualities — extends the full-payment period over a longer period of years, the individual payments being so small that the final price paid is lower.

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All purchasers are urged to insist upon inspection of the label and trade mark before purchasing to make sure that they receive the genuine Goetze Gaskets.

Further examination will show the exceptionally deep corrugation of the copper or other metal and the firmly embedded rings of high grade asbestos cord.

The two are combined to form the most resilient gasket made—that will not lose its "spring" or "life" under the hardest service conditions. It will expand and contract with the pipe and at all times will form an absolutely tight joint.

Note the wide range of application in the power plant and practically every modern industry.

To make your globe, angle and cross valves tight—replace their present discs with Goetze Valve Discs—made with a copper or other metal shell and live asbestos core.

A 90 days' free trial allowed in your plant.

GOETZE GASKET & PACKING CO.
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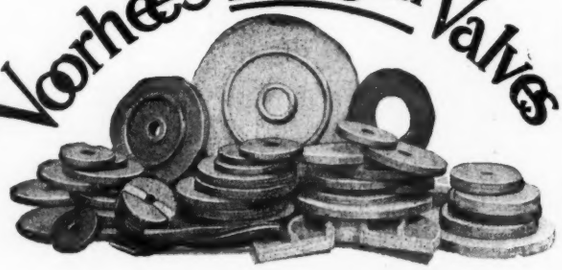
Voorhees Rub-Steel Valves



The Four Grades

Standard—Superhot—Special Soft—Red Condenser

Standard:—For clean water; Elevator pumps; high pressures in water not exceeding 160 deg. May be used with excellent effect on undercut bridges. Fluid flows straight outward.

Superhot:—For Boiler Feeds, Oil, Acid, Ammonia, Vacuum Returns, Marine Air Pumps, Gasoline. Highest temperatures within 250 deg.

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Red Condenser:—Highest Vacuum, excessive grit, Pottery Slip, Soda Ash, Brine, Sugar Mill Vacuums, Paper Stock Pumps. Temperature limitations 115 deg.—pressure resistance up to 70 lbs.

Samples of any or all grades sent upon request for free trial. Write TODAY.

Voorhees Rubber Mfg. Co.
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"Lion" Auto Hydraulic

SEND for sample of "LION" Packing for either steam or water.

Then you will see why "LION" is imitated in style, but unmatched for service.

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Belt User's Book Free

Users find it helps them get the most from their belts.

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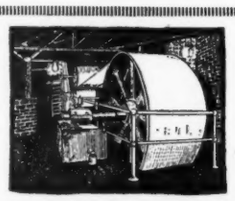

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Manufactured Solely by
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THE CORRECT BELT FOR THE DRIVE

Ten inch and fifteen inch G & K belts on generator drives in the power plant of a large manufacturing concern.

Call a plumber, the piano needs tuning

About once in a blue moon you might get a plumber who could tune the piano. But very likely, you don't care to take chances on getting the one who could.

Guesswork belting is just as uncertain. There is no universal belt. Each type of drive operates under conditions peculiar to it alone, and that drive demands a belt made especially for it. Unless it has this correct belt, your power will be wasted and your production cut down.

G & K engineers have gone into every leading industry, studied actual conditions and designed the correct belt for each drive—the belt that transmits the full rated horsepower day after day.

You may have their findings and specifications for your industry, either to check up on present belting or to determine the correct belting for new installations. Just send a card, asking for book 101U. A copy will be sent free.

This trademark is the symbol of the scientific control of tanning and manufacturing processes and the application of the correct belt for every drive in every industry.

The Graton & Knight Mfg. Co.

WORCESTER, MASS.

Oak Leather Tanners, Makers of Belts and Other Leather Products

Distributors and Branches in All Principal Cities

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Graton & Knight

Standardized Series Leather Belting

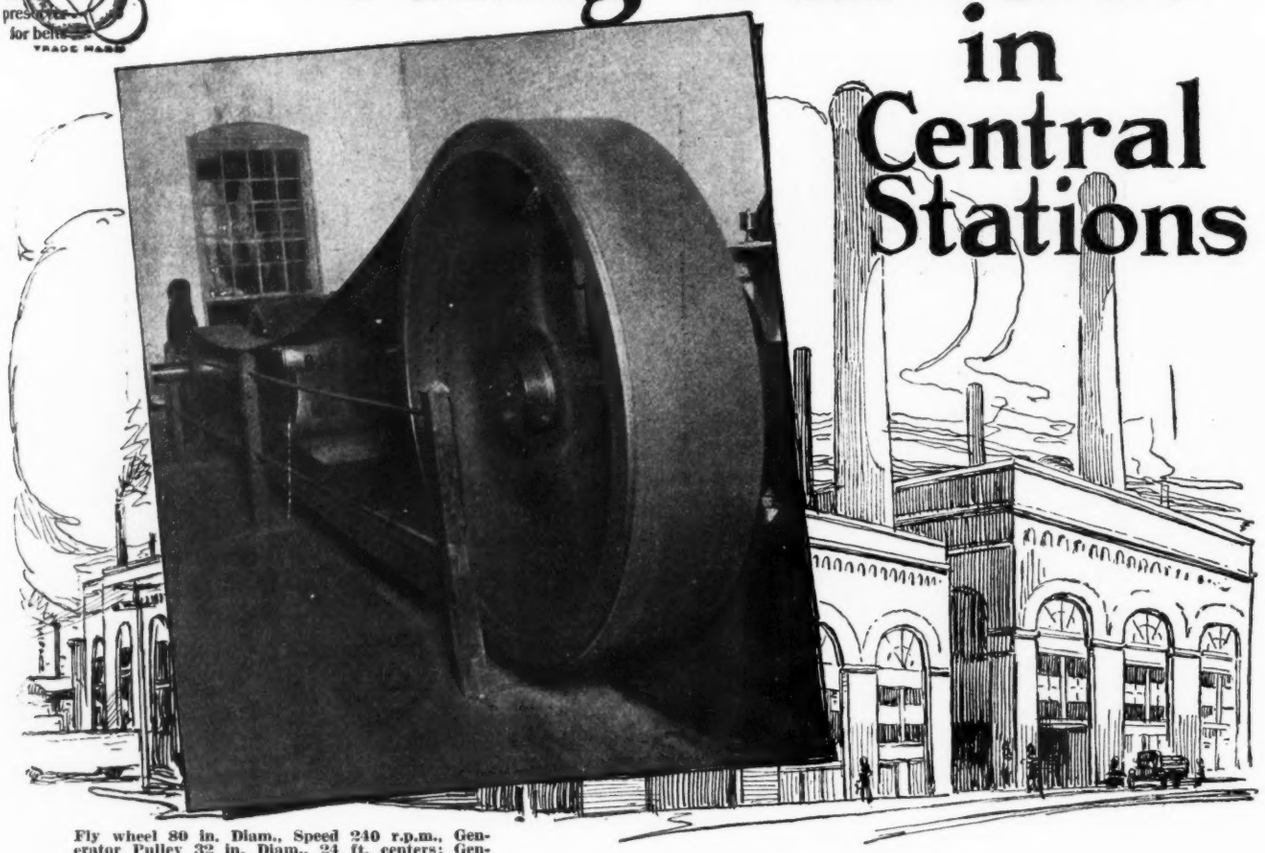
Tanned by us for belting use

Cling-Surface

the life preserver for belts

TRADE MARK

Cling-Surface in Central Stations



Fly wheel 80 in. Diam., Speed 240 r.p.m., Generator Pulley 32 in. Diam., 24 ft. centers; Generator 200 kw., 3 phase, 2300 volt, 60 cycles; Belt, 3-ply leather.

In no plant are the benefits more apparent or more easily obtainable from slack-running belts than in a Central Station. And yet many Central Stations continue to run their belts tight.

Tight belts are a relic of old times; an outgrowth of a reasoning having for its foundation the shallow thought "belts slip because they're loose; so we'll tighten 'em."

And thus, while the engineer is working hard to maintain a tension which is stretching the belts and heating the journals, he is using up valuable power to overcome the very tension that he has created.

Which means that he pays a heavy price for his slip-elimination theory, when a little study of the Cling-Surface Way would show him that Cling-Surface stops slipping better than does tension and without the unnecessary strain.

The belt pictured (Wilkes-Barre Light Co., Wilkes-Barre, Pa.) is running slack with load of 220 hp. but when load is off it runs so slack that it slaps the floor. When Cling-Surface was first applied the belt had been running three months, was oily and dirty, and tightener could not make it hold; now no trouble whatever is experienced—Cling-Surface has stopped all slipping!

Running belts slack under Cling-Surface treatment means cooler bearings, less oil, fewer repairs, no worry, *and* more power at the machines. The power formerly lost from slipping, or in overcoming the friction produced by tension, goes through to the machines and is available for sale.

Cling-Surface has been giving this service for over 25 years, *and nothing but Cling-Surface ever has done so.* Easily proven: CLIP THE COUPON.

Let "Cling-Surface Clarence" usher in the New Year in reality. He greets you with the usual seasonal greetings—plus the unusual opportunity to gain better belt-service. Clip the coupon and he'll bring you a can.

Cling-Surface Co., 1049 Niagara St., Buffalo, N. Y.

Gentlemen: Send us a 50-lb. can of Cling-Surface with full instructions and guarantee. If we are satisfied with results of its use at the end of 60 days, we shall forward payment—but not unless we are satisfied.

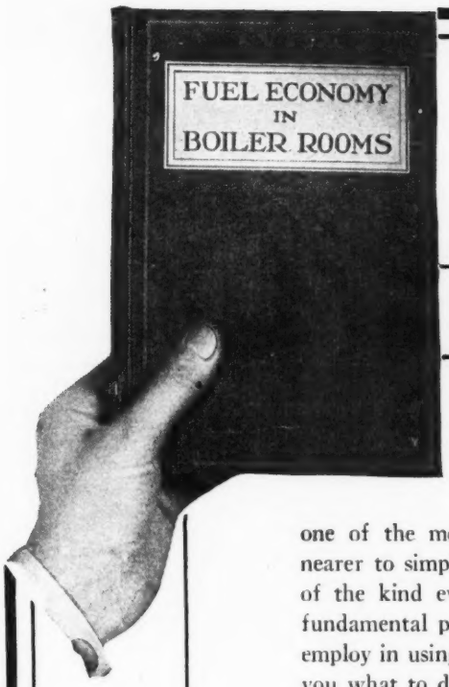
Name .....

Address .....

A check mark here ☐ means we want further information about SAYAC. 12-28-20

CLING-SURFACE COMPANY

1049 Niagara Street, Buffalo, New York, U. S. A.



Fuel Economy

Here at last is a complete, understandable book that specializes on the one subject of saving fuel—a work that has been pronounced one of the most important books of today because it comes nearer to simplifying the economical use of fuel than anything of the kind ever written. Its 302 pages take you from the fundamental principles of combustion to the actual methods to employ in using the fuel. Definitely, accurately, clearly, it tells you what to do, and how to do it. It solves your problems—answers your questions—tells you just what you want to know about necessary theory, and emphasizes—goes into detail on—the actual practice.

It is by no means rare to find plants in which economies of 25 or more per cent have been effected by the application of the ideas, plans and practices which "Fuel Economy in Boiler Rooms" makes so easily understood. Even if the saving were but 10 per cent in your plant, is it not more than worth while to accomplish it **now?**

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Send me POWER every week for one year beyond the date to which my present subscription is paid. (If a new subscription, check here.....) And send me at once "Fuel Economy in Boiler Rooms." If the book does not prove satisfactory, I'll write you in 10 days for instructions for its return at your expense. Otherwise, I will remit your special combination price of $4.80 on receipt of your bill. Extra zone postage west of the Mississippi, and in Alaska, Hawaii, the Philippines, Porto Rico, Canal Zone, Cuba and Mexico, $1. Extra postage in Canada, $1. Extra Foreign postage $3.
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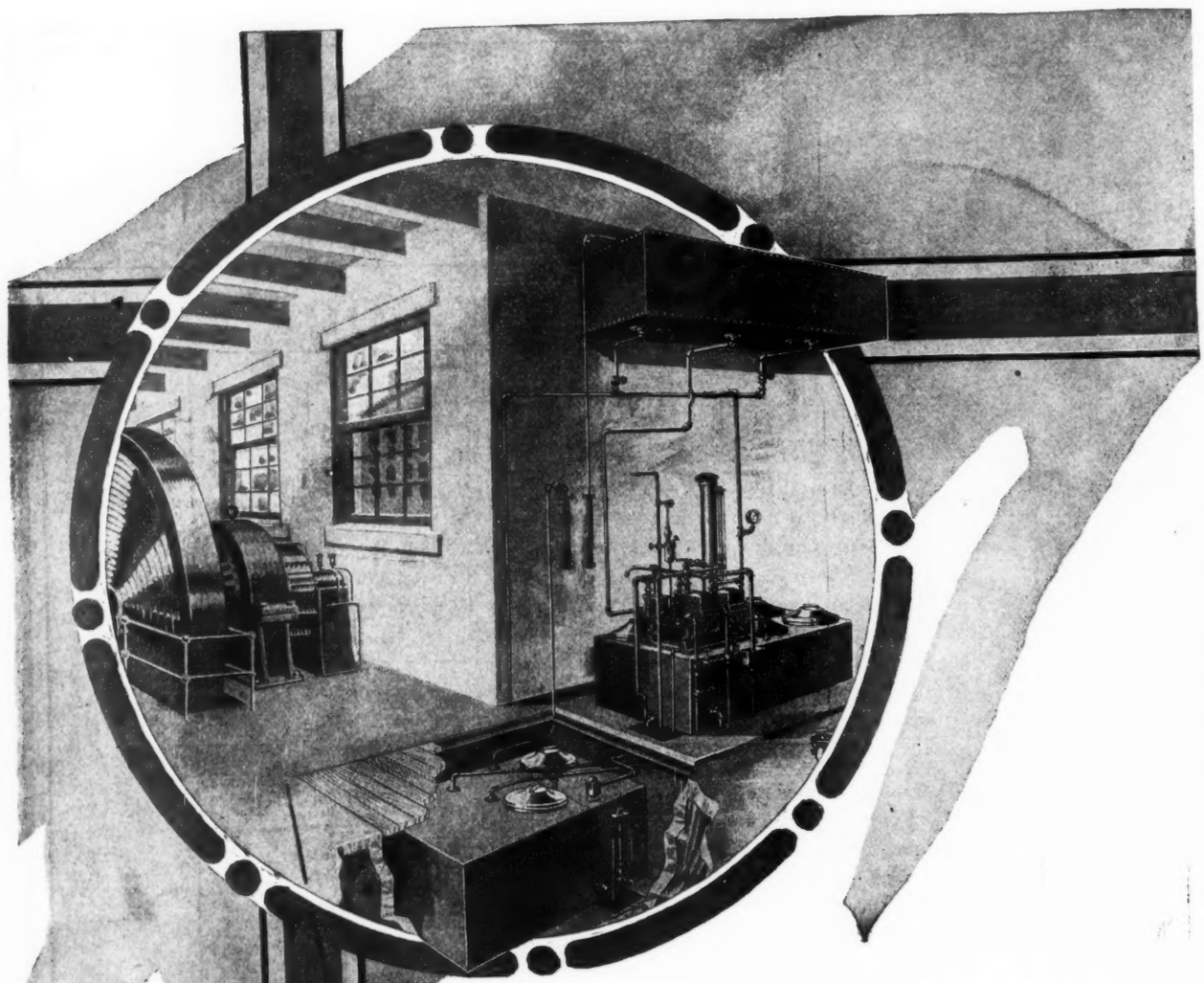

Saving of Fuel By Reducing Friction

Much of the friction on engines is due to irregular hand feed lubrication or using oil which is dirty and contains impurities. This increased friction necessitates the consumption of more coal to produce the required power.

Reduce This Friction By Installing a Bowser Stream Feed Circulating and Filtering System.

A close study of operating costs in power plants has proven conclusively that there is a reduction in friction and a saving of approximately 5% in the fuel costs where stream feed lubrication is in practice as compared with hand lubrication methods.

In a plant of only ordinary size, a year's saving in the reduced friction will pay for the installation of a Bowser Stream Feed Lubricating and Filtering System.

Write for our illustrative booklet showing our various filtration systems.

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Fort Wayne, Indiana, U. S. A.

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S. F. Bowser Co., Ltd., Toronto.

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The Spirit of Our Trade Mark

THE homely but substantial motto, "Time Tells", which is embodied in our trade mark, characterizes every relation with our customers.

"Time Tells" a story of growing mutual satisfaction, of our integrity of purpose, and of putting into practice the spirit that a contract IS a contract. Our trade mark is a challenge to real service.

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Caustic Soda, Soda Ash and Linseed Oil for immediate shipment from Chicago stock.

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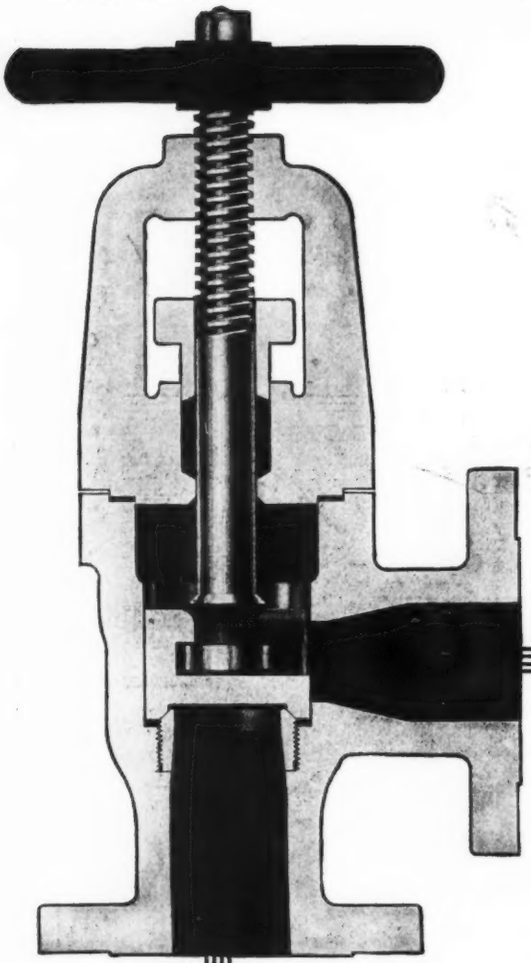

No. 391 Flanged
No. 390 Screwed

CRANE

EXTRA HEAVY

Blow-off Valves

Comply with the A. S. M. E. Boiler Code

We recommend these valves for use as blow-offs on high pressure boilers and all other purposes where it is desirable to blow off dirty water, or water containing grit or sediment, under pressure.

This service, therefore, requires a valve which can be repaired quickly and cheaply. To prevent too frequent repairing we make these valves with a removable iron seat ring, having the seating surface on the outside of the ring. The disc also is made of iron.

This construction prevents scale from lodging between the seat and disc. The use of iron for this service in seat and disc is the result of many years experience with valves of this type.

1855 —— **CRANE CO.** —— 1920

836 South Michigan Avenue
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Branches in fifty-seven leading cities

We are manufacturers of 20,000 articles—valves, pipe fittings, steam specialties, etc.—for all phases of power plant equipment, and are distributors of pipe, heating and plumbing materials.

Those Steam-Consuming Auxiliaries —Are They Economical or Wasteful?

THE hundreds of Davis Regulators in service comprise but a fraction of the profitable applications for this steam saver.

It is continually overlooked—not because its saving is small, but because the device itself is small—because the waste it stops is not found in the beaten path of efficiency methods.

That driving engine, steam pump, or heating system operating on high pressure steam, is wasting coal in a degree that would not be tolerated in the boiler furnace where the waste of fuel is more apparent. The Davis Regulator will reduce high pressure steam to the proper lower pressure where such devices become efficient and economical—and automatically maintain this pressure regardless of variation in initial steam supply.

It is as certain as gravity—because gravity-controlled by a weighted lever arm. Inner valve is balanced at every point of its travel under all pressures. There are no springs or diaphragms.

This and the many other Davis steam savers (listed opposite) are described in the very complete catalog awaiting your request at the G. M. Davis Regulator Co., 420 Milwaukee Ave., Chicago.

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Water Control Valve
Back Pressure Valve
Exhaust Relief Valve
Stop and Check Valve
Emergency Stop Valve
Fluid Level Controller
Pressure Regulators
Water Relief Valve
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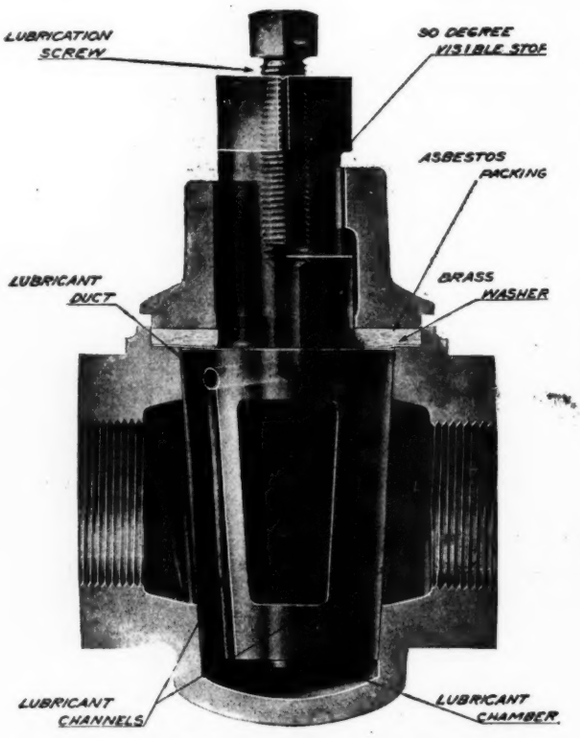
STEAM SAVERS SINCE 1875

THE MERCO-NORDSTROM Plug Valve, although all iron—on account of its superior lubrication, will withstand acids and caustic fluids for a long time. 100% opening in flow area. For various working pressures.

Write for descriptive Bulletin.

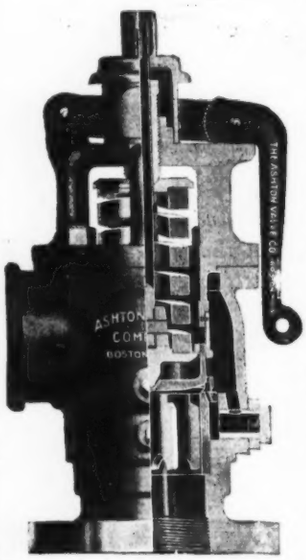
Please send orders to our nearest office.

THE MERRILL COMPANY
121 Second Street, San Francisco
Monadnock Block, Chicago, Ill.



In ordering, please state temperature, pressure and character of fluid to be handled; also whether acid, alkaline or neutral.

The Ashton Improved Outside Spring Pop Safety Valve



For use on Superheaters

is made of cast steel body, valve part and seat bushing of solid nickel. Has outside pop regulator, knife-edge pop-lip and compound lifting lever easily raised by hand, the set pressure adjustment being locked to prevent tampering.

The valve has proven eminently satisfactory on Superheat installations and is guaranteed to give perfect and enduring service.

Illustrated Catalog on Request.

The Ashton Valve Co.
161 First Street **Cambridge, Mass.**
BRANCH OFFICES:
137 Liberty St., New York **318 W. Washington St., Chicago**

"Whale Brand" Nickel-Bronze

Gives longest life and does not corrode. Used exclusively for disc and seats in New Bedford Valves. You protect your own interests when you install New Bedford Valves. Longest life—least attention. It's in the material and workmanship.

Write for further details now.

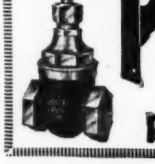
New Bedford Valve Manufacturing Company
Established 1872 **New Bedford, Mass.**

MOnel metal

MONEL METAL

Non-corrodible—strong as steel—tough and ductile. Withstands acids, high temperatures, erosive action of hot gases and superheated steam.

THE INTERNATIONAL NICKEL COMPANY
43 Exchange Place - - - New York, N. Y.



PRATT & CADY VALVES

Manufacturers of
Valves and Asbestos Packed Cocks

PRATT & CADY CO., INC., Hartford, Conn.

B

Globe, Angle and Check Valves
Steam Specialties

The Ohio Brass Company
MANSFIELD, OHIO

CONSTANT dripping of water wears away the stone—likewise constant dripping past leaky blow-offs wears away the earnings of the plant.

CADMAN INDESTRUCTIBLE BLOW-OFF VALVES

will stop that dollar wasting leakage. They have persistently demonstrated their ability to *hold tight* in continuous service, without attention.

Among their salient points are the whirlpool inlet, that causes the water to flush the seating surfaces free from scale, grit and dirt before closing, and the solidly anchored reversible monel metal seat. The monel metal disc is also reversible, and both are accurately ground to form a perfect circular arc contact that will let nothing get by.

The seating surfaces are not subject to scoring, hence regrinding is seldom necessary.

The Standard for Superheat

A. W. Cadman Manufacturing Co.

Main Office and Works

Pittsburgh, Pa.

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Write for a copy of the descriptive Bulletin

Start the New Year Right!

Let the G-W Specialists advise you in planning your coal—and ash-handling equipment. Whether you have a new plant in mind, or are just going to make changes in your present equipment, it will pay you to take up the subject with G-W engineers. They are capable and are backed by a concern with a well-founded reputation that merits your giving them a trial.

Tell us what you have in view—an estimate entails NO OBLIGATION.

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2 BALL & SOCKET CO., WEST CHESHIRE, MASS.
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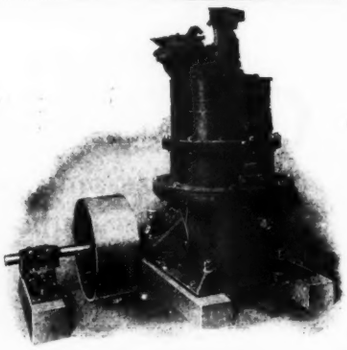
Mechanical Handling in all lines of Industry

Gifford-Wood Co.

MAIN OFFICE AND WORKS Hudson, N. Y. NEW YORK, BUFFALO BOSTON, CHICAGO

Coal Cost Cut with Pulverized Coal



Lignites and low-grade bituminous coal formerly considered as having no commercial value are now made available and transformed into efficient Steam Producing Fuels by

Pulverized Coal Equipment

The Fuller-Lehigh method of combustion means an end to slicing, barring, cleaning of fires.

No smoke. No waste. No trouble with headquarters.

Fuller-Lehigh Equipment is preparing over 25,000 tons of Pulverized Coal every day for Industrial and Power Purposes. The satisfactory performance of our equipment warrants your investigation.

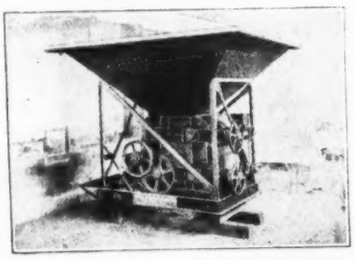
Ask for Catalog No. 71

FULLER-LEHIGH COMPANY

Main Office: Fullerton, Pa., U. S. A.

New York, N. Y., 50 Church St.; Chicago, Ill., 1336 McCormick Bldg.; San Francisco, Calif., 719 Sheldon Bldg.; Seattle, Wash., 714 L. C. Smith Bldg.; 25 Victoria St., Westminster, London, S.W.1., England; "Wallhoft," Glockengiesserwall 2, Hamburg, Germany.

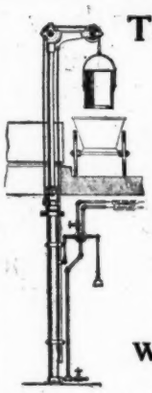
Orton & Steinbrenner Co.
Dependable Coal Crushers



Produce clean and uniform coal, graded for stoker use, and free from dust and "fines." Rolls can be separated to allow coal to pass between, without running the crusher. All wearing parts built of cast steel, insuring longest wear and lowest maintenance expense.

ORTON & STEINBRENNER CO.

Factory: Huntington, Indiana 608 S. Dearborn St., Chicago



THE DEAN ASH HOIST

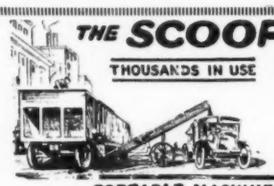
Will lift a can of ashes, or other material, to the street level quickly, by means of air, steam or hydraulic pressure.

Operating valve simple in construction. Piston made of polished steel tubing; cylinder is of lap-welded pipe. Compact construction; nothing to get out of order. Automatic in action to retard piston speed and stop at limits of piston stroke without shock. Durable and efficient.

Complete information upon request. Our engineering department is at your service.

WASHBURN & GRANGER, INC.

50 Church St., New York City



THE SCOOP CONVEYOR

THOUSANDS IN USE

FOR STORING AND RECLAIMING, LOADING AND UNLOADING CARS, TRUCKS AND WAGONS

DOES THE WORK OF FROM 6 TO 12 MEN AND KEEPS EQUIPMENT MOVING

WRITE FOR LITERATURE

PORTABLE MACHINERY CO., PASSAIC N.J.

Webster Equipment

Elevating, Conveying and Coal Rehandling Machinery

Put your problems up to the engineers of a company which has ranked high for over forty years.

The Webster M'f'g Company

Factories in Chicago and in Tiffin, Ohio
Executive Offices: 4500 Cortland St., Chicago

Sales Offices in Principal Cities

Girtanner

Standardized Steam Ash Conveyor

Removes ashes mechanically. Saves labor, saves money. Ask for Booklet No. 5.

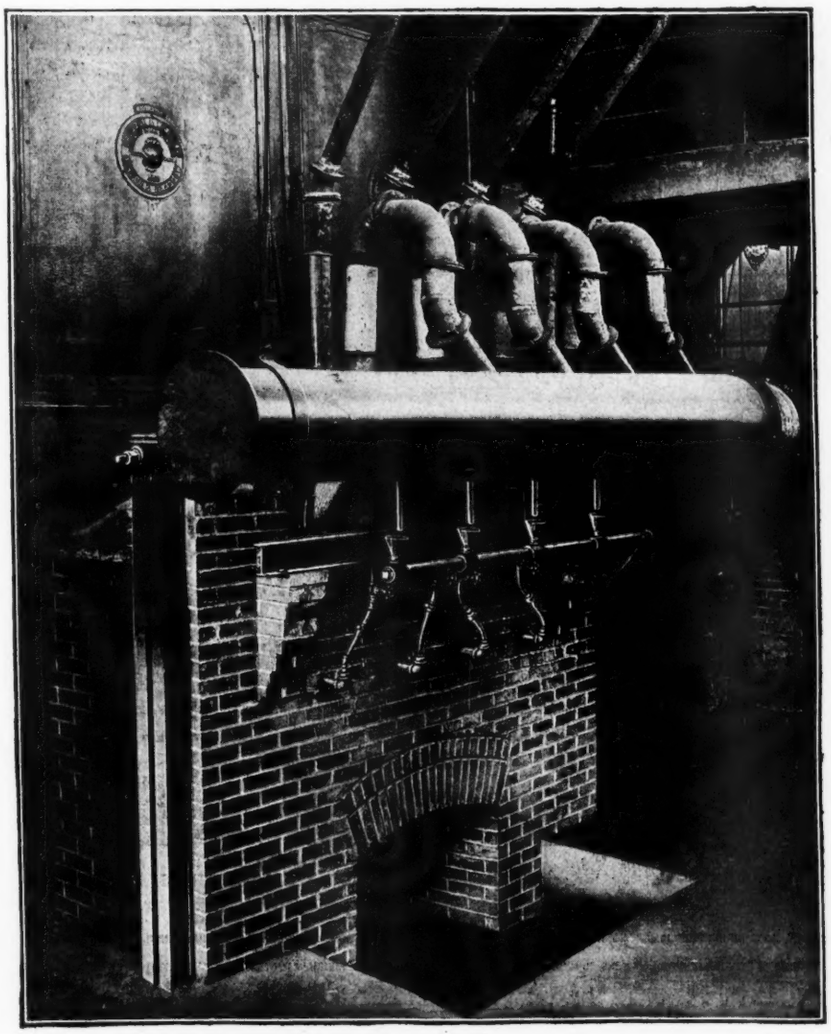
GIRTANNER ENGINEERING CORP.
1100 Broadway, New York

First aid to overworked labor and overburdened payroll. Self-contained, easily and fully controllable, speedy digging and rehandling machine for indoor and outdoor use. Hooked up in a jiffy to any lifting machine. Catalog 44.

THE HAYWARD CO., 44-50 Church St., New York

The Advantages of Natural Gas Plus the Economy of Coal

Even with inferior coal these advantages are definitely offered to steam power plants of more than 500 H.P. capacity by the



Application of the Holbeck System to a steam boiler. Any one or more of the four burners may operate separately. Changes instantly from minimum to maximum capacity and back again by regulating four valves.

HOLBECK Pulverized Coal SYSTEM

Full Steam During Overloads —Fuel Economy when the load is reduced—30% to 60% more steam from every car load of coal—complete freedom from expensive shut-downs caused by boiler room troubles.

The distinctive feature of the HOLBECK SYSTEM is that it is just as easy to regulate as natural gas, just as easy to start and stop, just as flexible and burns with a hotter flame. Smokeless combustion can be maintained with almost any grade of coal.

Our engineers have records showing as high as 50% savings of labor expense and 35% savings of fuel expense in power plant operation.

If you are curious to know what the HOLBECK SYSTEM can do for you, they will be glad to make you a careful estimate, with the understanding that the inquiry places you under no obligation

HOLBECK
PULVERIZED COAL SYSTEMS

The Bonnot Company
POWER PLANT DEPT.
Canton, Ohio

258 Frick Annex, Pittsburgh, Pa.
Continental and Commercial Bank Bldg., Chicago, Ill.
1402 Morris Bldg., Philadelphia

POOR COAL

Poor coal has no terrors for the plant equipped for powdered coal—

LOPULCO SYSTEMS

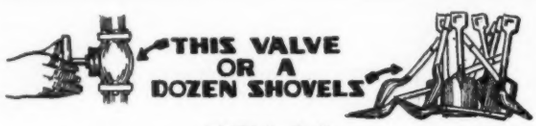
are showing practical results daily in plants using a great variety of coals.

Nothing to think of but starting and stopping with a Lopulco System.

Combustion Engineering Corporation
11 Broadway, New York City

Owners and Manufacturers of
LOPULCO PULVERIZED FUEL SYSTEMS

Type E Stokers—for Bituminous Coal
The Grieve Grate—Hand Firing
Coxe Stokers—Anthracite Coal and Coke Breeze



Which?

Hammelizing your boiler plant accomplishes much more than the generation of power at a lower fuel cost.

Eighty per cent. of the direct labor in a boiler plant may be saved through the Hammel System, the capacity of boiler and stack greatly increased, instant flexibility always available.

Hammel Oil Burning Equipment Company
185 Devonshire St., Boston, Mass.

HammeL *OIL BURNING SYSTEMS*

\10-1.

EYNON-EVANS
Blowers Exhausters Injectors Ejectors
High Grade Valves
EYNON-EVANS CORPORATION
15th & Clearfield Streets, Philadelphia, Pa.

SIMPLEX
STEAM JET CONVEYORS
For Handling ASHES, SOOT, COAL SIFTINGS, FURNACE DUST, LOCOMOTIVE CINDERS.
United Conveyor Corp., Old Colony Bldg., Chicago, Ill.

QUIGLEY POWDERED COAL SYSTEM

Reliability
Cleanliness
Economy

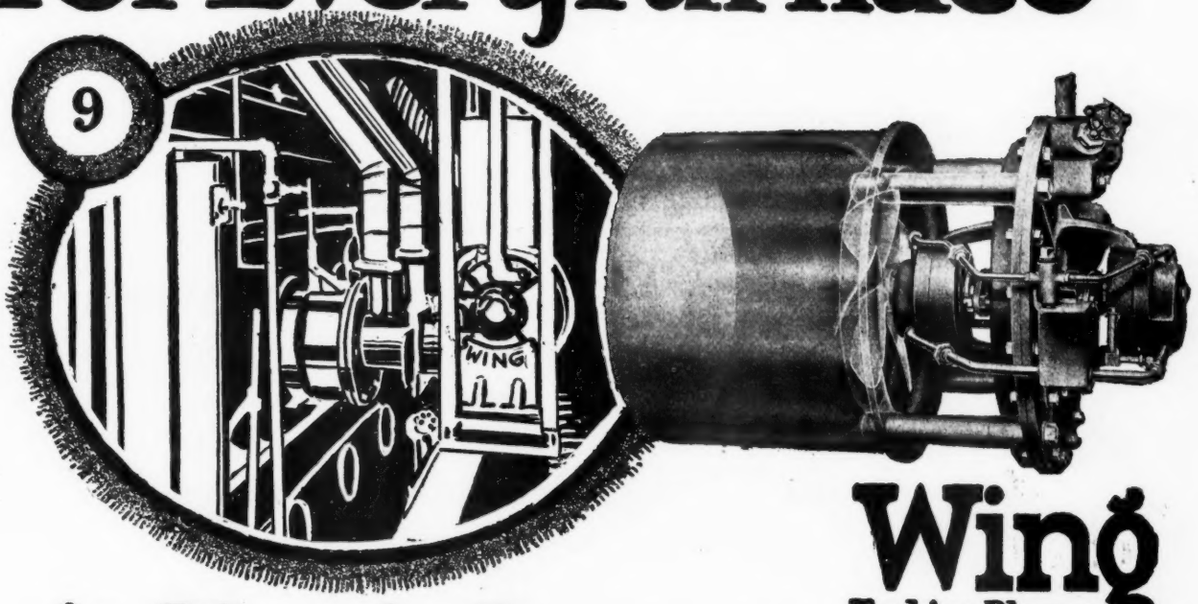
The only system where accurate records of fuel consumption are made possible and where pulverized coal can be transported long distances with absolute reliability and cleanliness.

Quigley Furnace Specialties Co., Inc.
26 Cortlandt St., New York, U.S.A.

USE J. R. S. FUEL BURNERS
These will keep the plant running
All Grades of Fuel Consumed Including Screenings, Coke Breeze, Etc.
Mechanicville Specialty Supply Mfg. Company
Mechanicville, N. Y.

OIL BURNERS
WRITE FOR BOOKLET "P"
Tate-Jones & Co. inc.
Pittsburgh, Penna.

For Every Fuel For Every Furnace



Wing Turbine Blower

Air Blast for Burning PULVERIZED COAL

The Original In 1905 **The Standard Since 1905**

The advantages of burning pulverized fuel are today being brought to the attention of the engineering public. The fuel, after passing through crushers is *blown* into the furnace; the blast which carries the coal supplies part of the air required for combustion.

The Wing Turbine Blower is used in this type of furnace to blow the coal. The balance of the air is furnished by inspiration.

This is another of the many diversified applications of Wing Blowers in combustion. The Wing merits your investigation.

The blowers used in this type of installation are sometimes of the propeller type, sometimes centrifugal. In the latter, the simple, light, economical Wing Turbine is supported by heavy reinforced studs from the casing of the blower. The fan is mounted on the turbine shaft.

Thus a direct-connected unit is had, which is exceedingly compact, yet delivers high volumes at pressures of several ounces. Of course these units are equipped with the Wing System of automatic lubrication.

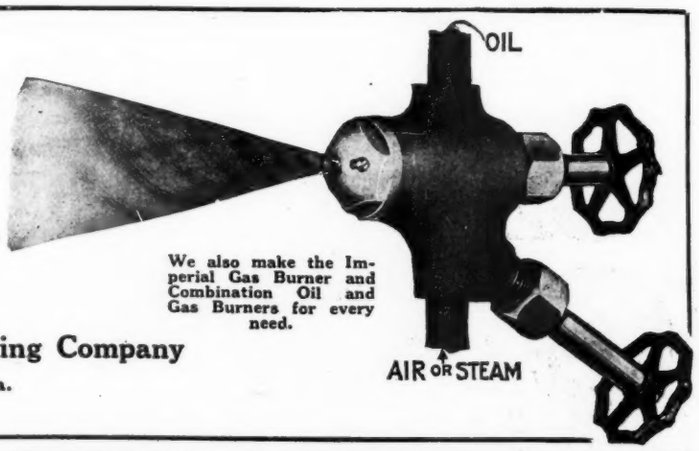
Have you a copy of Wing Bulletin 57?

L. J. Wing Mfg. Co.
9th Avenue and 13th Street, New York

Manufacturers of Blowers, Damper Regulators, Ventilating Fans, Pressure Blowers, Vacuum Pumps and Small Turbines

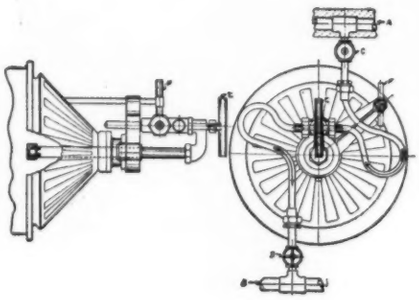
Wing—the Standard Forced Draft

DAVISON Oil and Gas Burners will cut down your steam cost, by burning oil or gas, or a combination of the two under your boilers. Make your plant independent of the coal situation with DAVISON Burners. *Write for further details.*



We also make the Imperial Gas Burner and Combination Oil and Gas Burners for every need.

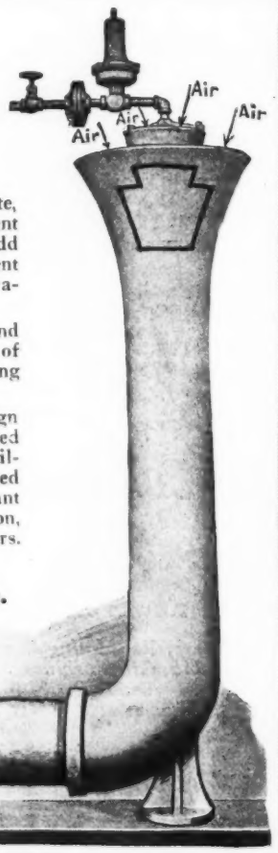
N. C. Davison Gas Burner & Welding Company
3143 Penn Ave., Pittsburgh, Pa.



The Hagan System
of Burning Liquid Fuel
Complete equipment for
Steam Power Plants
Industrial Furnaces
Let us solve your Oil Burning Problems

GEORGE J. HAGAN CO.
Combustion Engineers PITTSBURGH

Keystone Draft Blowers



INCREASED combustion rate, and the possibility of efficient use of low grade fuels will add capacity to your boiler equipment without added difficulties of operation.

Properly proportioned steam and air blast prevents formation of hard clinkers, making cleaning through fire doors unnecessary.

Keystone Steam Nozzle design enables the blower to be operated continuously without the possibility of having nozzle ports limed shut. This is a most important feature in jet blower operation, obtained only in Keystone Blowers.

Marion Machine Foundry & Supply Co.
Marion, Ind.

Grates
Soot Blowers
Draft Blowers
Coal Mining & Handling Equipment
Patent Water Gauges

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Let them supply your forced draft at a large saving in operating and upkeep cost.

Built in sizes to handle from 1600 to 275,000 cu.ft. per minute at pressure up to 7 inches of water.

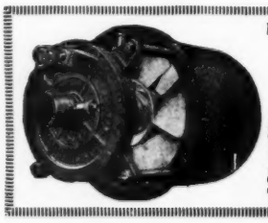
Learn why they are more efficient. Write for Bulletin No. 152.

THE GREEN FUEL ECONOMIZER CO.
BEACON, N.Y.

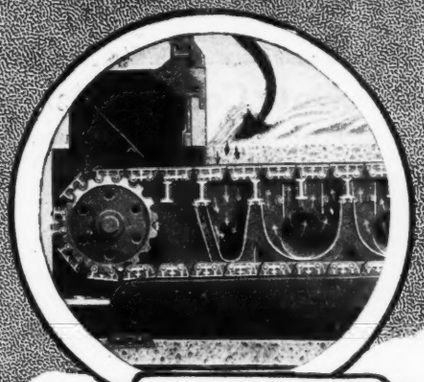
REGISTERED
COPPUS
U.S. PAT. OFFICE

TURBO-BLOWERS and TURBO-FEED PUMPS
See our 2 page advertisement in alternate issues

Coppus Engineering & Equipment Co., 350 Park Ave., Worcester, Mass.



POWER SIMPLEX
Turbo-Blowers
Turbines—Damper Regulators—Turbo Pumps
Power Turbo Blower Co.
347 Madison Ave., New York
710 Witherspoon Bldg., Philadelphia
140 S. Dearborn St., Chicago
Agents for Canada: The Canadian Stoker Co., Ltd., Galt and 15 Rusholme Rd., Toronto, Ontario, Canada.



Thereverse flow of gases means positive ignition athigh combustionrates.

Ignite Coke Braise Properly and You Burn it Without Difficulty

IT is not difficult to burn coke braise on a chain grate stoker. But it is hard to ignite it properly—hence the dread that has caused many plants to lose sight of its great economy.

To Illinois equipped plants coke braise holds no terrors. The one obstruction to satisfactory combustion is removed by

Illinois Mechanical Ignition

An Exclusive Feature

Directly below the fuel gate a tuyere, operated under induced draft conditions, draws a small portion of hot gas through the incoming coal.

The amount of hot gas thus reversed can be varied at will by the operator to produce thorough ignition. Thereafter the coke braise is burned under forced draft conditions regulated by the famous Illinois system of dampered air control.

If this economical fuel is available to your plant, you cannot afford to delay investigating the possibilities of efficiently burning it on the Illinois Type "G" Forced Draft Chain Grate equipped with Illinois Mechanical Ignition. Illinois engineers will gladly acquaint you with all the details. Write.

Illinois Stoker Company
104 W. 7th St., Alton, Ill.

CHAIN GRATE ADVANTAGES—

The basic principle of any chain grate stoker insures:

- —total freedom from clinker trouble
- —lowest labor costs
- —absence of steam-consuming auxiliaries for removing clinkers.

Illinois Stokers have these additional advantages:

- —forced draft for overloads
- —dampered air control
- —mechanical ignition for burning high moisture, low volatile coals.

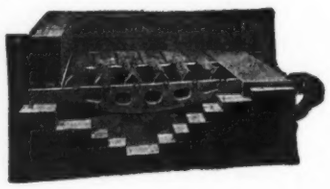
ILLINOIS STOKERS

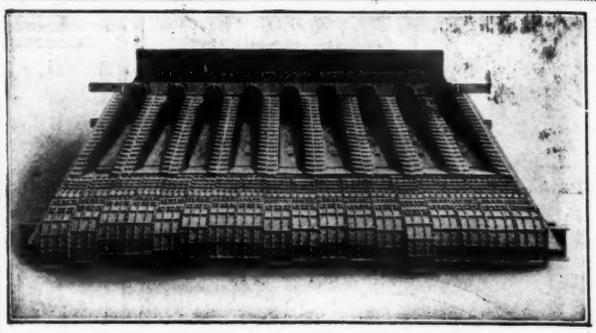
CHAIN GRATE With Dampered AIR CONTROL

CYCLONE Grates burn the coal easily and thoroughly—the draft draws in fresh air (68% of the available air) to every part of the fire, in quantities to assure almost complete combustion. Clinkers cannot form, and practically every heat unit is made to do useful work.

Write for further information

Cyclone Grate Bar Co.
Buffalo, New York





Riley Stoker Grate Construction

Each and every line of grates, extending from the front to the rear, can be operated independently of all others.

RILEY UNDERFEED STOKERS

It is therefore possible by changing the length of movement of one or more of these grate sections—to alter the condition of the fuel bed in any one spot, in front or back, without affecting the general condition of the fire.

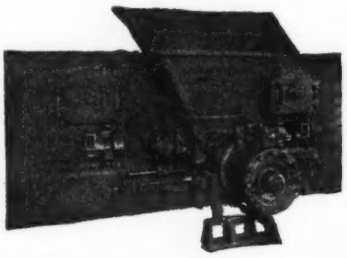
A Riley fuel bed means—better operating conditions—higher efficiency—greater capacity—less fuel and labor—and reduced maintenance.

Catalog P-12 explains the live grate construction.

Sanford Riley Stoker Co.
WORCESTER, MASS.
Boston New York Philadelphia
Pittsburgh Buffalo Cleveland
Detroit Cincinnati Chicago
Denver St. Paul

THE ROACH STOKER

has greater capacity and dependability and is more efficient.



Write for the new bulletin

JOSEPH H. ROACH & CO., Inc.
221 So. 15th Street, Philadelphia, Pa.

MODEL AUTOMATIC SMOKELESS FURNACE

Burns the cheapest coal at high efficiency.

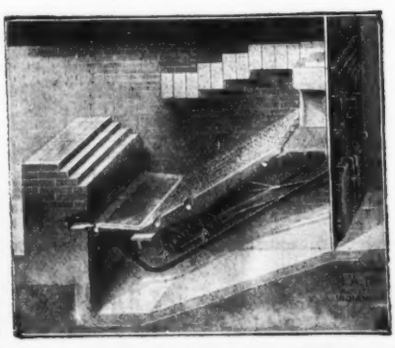
Model—Chicago Chain Grate Model—Acme Engine

THE AUTOMATIC FURNACE COMPANY
Dayton, Ohio

HUBER HAND STOKER

Sole Manufacturers
FLYNN & EMRICH COMPANY, Baltimore, Maryland

NATIONAL STOKER



The National hand-operated Stoker is widely used for heat-treating furnaces, oil stills and oil cracking furnaces. Comparative tests made under actual operating conditions of National and mechanical stokers indicate that the National saves about 20% in the cost of evaporation.

The M. A. Hofft Co.
Indianapolis, Ind.
14

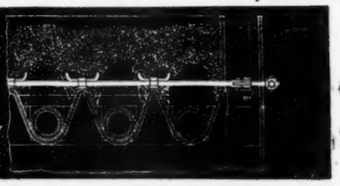
Brady Power Plant Equipment

Traveling Grate Stokers Steam Jet Ash Conveyors
Automatic Coal Scales Flat Furnace Arches

Write for Catalog

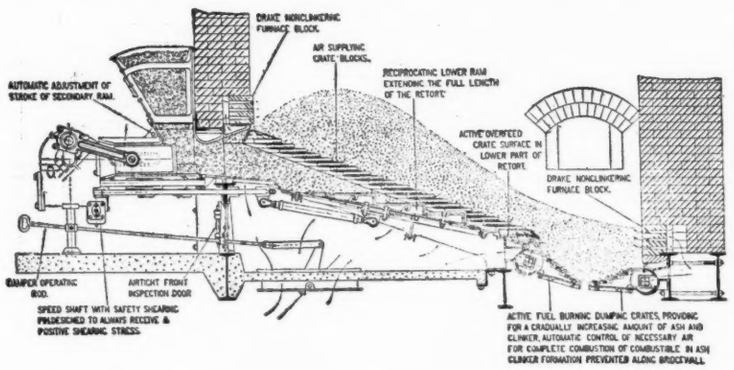
THE JAS. A. BRADY FOUNDRY CO.
45th St. and Western Blvd., Chicago

THE NEGUS-TIFFANY COAL AGITATOR
WET COAL DIFFICULTIES DEFINITELY CURED
W. E. ELLIS COMPANY
HAVERHILL, MASS. U.S.A.



Frederick *Underfeed* Stokers

High Heat Output From Poor Fuels


DRAKE NONCLINKERING FURNACE BLOCK
AIR SUPPLYING GRATE BLOCKS
AUTOMATIC ADJUSTMENT OF STROKE OF SECONDARY RAM
RECIPROCATING LOWER RAM EXTENDING THE FULL LENGTH OF THE RETORT
ACTIVE OVERFEED GRATE SURFACE IN LOWER PART OF RETORT
DRAKE NONCLINKERING FURNACE BLOCK
DAMPER OPERATING ROD
AIRTIGHT FRONT INSPECTION DOOR
SPEED SHAFT WITH SAFETY SHEARING PINS DESIGNED TO ALWAYS RECEIVE A POSITIVE SHEARING STRESS
ACTIVE FUEL BURNING DUMPING GRATES, PROVIDING FOR A GRADUALLY INCREASING AMOUNT OF ASH AND CLINKER, AUTOMATIC CONTROL OF NECESSARY AIR FOR COMPLETE COMBUSTION OF COMBUSTIBLE IN ASH CLINKER FORMATION PREVENTED ALONG BRIDGEWALL

The lower priced caking, or clinkering coals can be burned smokelessly at high economy due to the more thorough air distribution through the large underfeed grate section and the admission of air to the dumping grate and at the front and bridge walls through openings in special furnace blocks set in the brickwork.

The flexibility in the control of the secondary rams permit the fuel bed to be properly shaped for the thorough distillation, mixture and combustion of the volatile gases.

The simplicity of the design, with no moving parts exposed to the fire and no secondary dampers to adjust insures the highest practical operating economy.

Before deciding on your stoker equipment, consult our experienced engineering department. *Write us for full particulars.*

Excelling Features

1. The entire fuel supporting surface consists of active grate surface.
2. A maximum possible underfeed grate area per retort.
3. The entire length of the retort bottom consists of a secondary fuel moving section to agitate and move the entire fuel bed uniformly toward the bridge wall.
4. The stroke of the secondary fuel moving section is independently controlled by means of quick acting automatic adjustment.
5. Each gear box is furnished with a two-speed sprocket arrangement operated by means of a positive friction clutch to give individual fuel feeding control of each section.
6. The ash and clinkers are discharged through an air-cooled dumping grate.
7. Each gear box has a safety device, correctly designed so that each main ram may be blocked at any point of its stroke without damage to the stoker.
8. Front and bridge walls are protected by clinker preventive structures.
9. Simple design, low installation cost.
10. Low maintenance.
11. High fuel burning efficiency.
12. Large fuel burning capacity.
13. Automatic control of fuel and air.
14. Instantaneous flexibility to conform to load requirements.

THE FREDERICK ENGINEERING CO., Frederick, Maryland, U.S.A

Main Sales Office: 61 Broadway, New York

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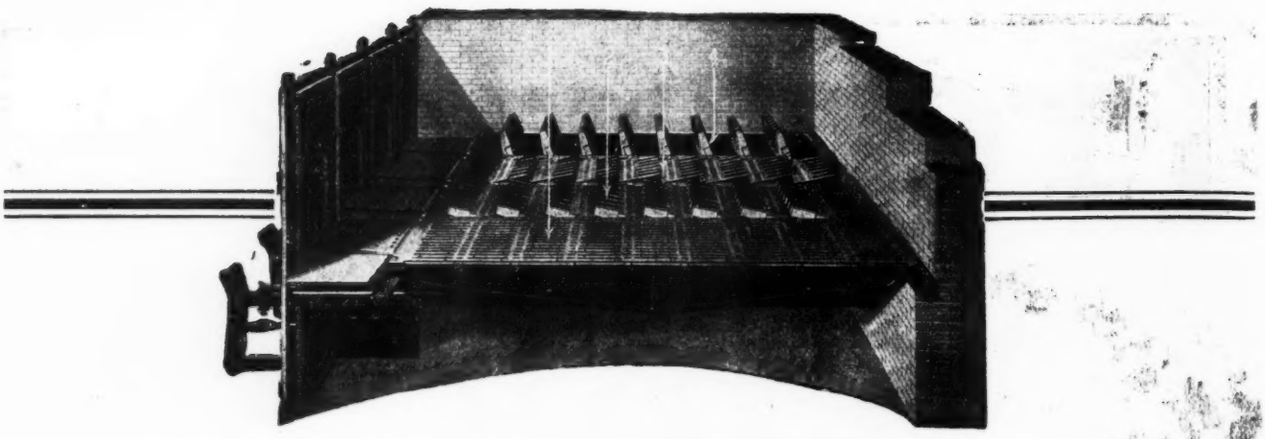
Cleveland, Ohio, Leader-News Bldg. | Pittsburgh, Pa., Jenkins Arcade Bldg. | Philadelphia, Pa., Stock Exchange Bldg. | Chicago, Ill., Marquette Bldg. | Birmingham, Alabama, Brown-Marx Bldg. | Boston, Mass., Broad Exchange Bldg.



The secret of efficient combustion is an assured even air distribution under the fuel bed with no obstructions against the air in entering. These conditions are met in full by

ARMSTRONG SHAKING GRATES

Armstrong Grates will enable you to keep your air spaces always open, allowing free action of the air to all parts of the fire, insuring perfect combustion.

The individual interlocking finger motion—in which projecting fingers from each grate section pass up and down through the opposite spaces of adjacent sections—absolutely prevent fusion of clinker in the air spaces.

A patented device prevents the grates from moving too far in either direction, thus giving a sifting action that eliminates the loss of coal into the pit. In dumping the grates tip almost vertically, giving an opening that will easily allow a 6-inch clinker to pass through.

A thirty days' trial at our risk will convince you of the necessity for Armstrong Grates under your boilers. Ask us about our guarantee. *It's different.* Write for Bulletins.

THE ARMSTRONG MFG. CO., Springfield, Ohio

IT is true economy to burn cheaper coal—*without loss of efficiency* on the NEEMES Grate. Will help to make 1921 more prosperous.

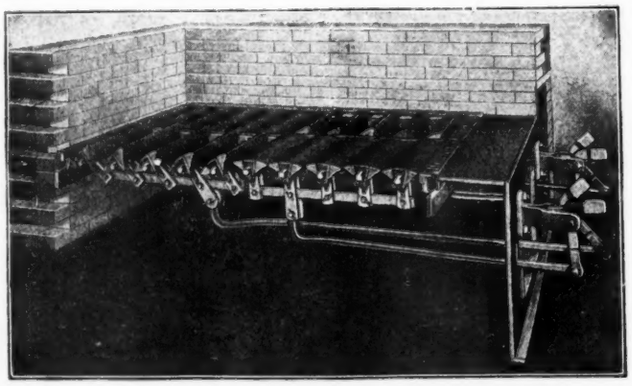
Write for further details.

NEEMES BROTHERS, Inc.

41-49 Adams Street, Troy, New York

Manufacturers of Round and Square Grates

Babcock & Wilcox, Ltd., Montreal, Canada, Sole Makers for Canada. Burke Engineering Co., 525 Industrial Building, Providence, R. I., Sole Agents for the New England States.

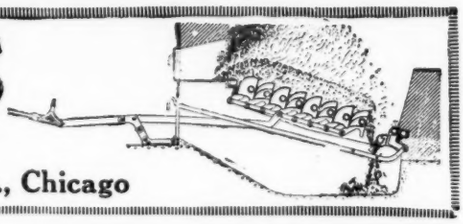


COKAL HAND STOKERS

Hundreds of satisfied users report saving of fuel and increased boiler capacity.

Write for Catalog.

COKAL STOKER CORPORATION, 1027 No. Clark St., Chicago



Files Stokers

Hand Operated

Write for Bulletin "G"; it will prove of real interest.

THE FILES ENGINEERING CO., Inc., Providence, R. I.

The Under-Feed Stoker Co. *of America*

General Offices: Book Building, Detroit

BOSTON, BUFFALO, CHARLOTTE, CHICAGO, CINCINNATI, CLEVELAND, DENVER, KANSAS CITY, MINNEAPOLIS, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, SALT LAKE CITY, SEATTLE

The Under-Feed Stoker Co. *of Canada, Ltd.*

81 Victoria Street, Toronto

Sole manufacturers in the United States and Canada of the Jones Under-Feed Stoker

Detroit Stokers

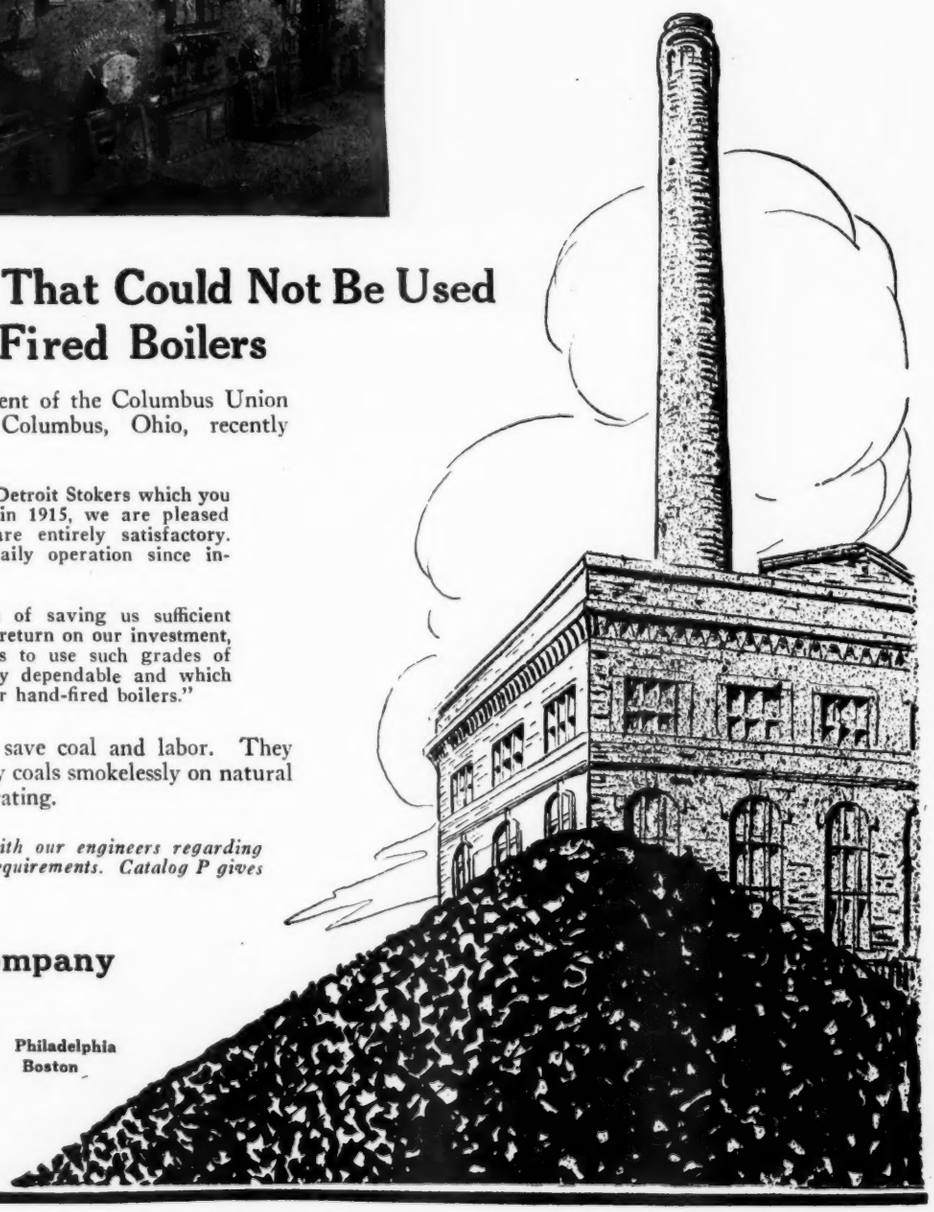
Burning Coal That Could Not Be Used Under Hand-Fired Boilers

Mr. R. H. Wilcox, president of the Columbus Union Oil-Cloth Company of Columbus, Ohio, recently wrote:

> "With reference to the Detroit Stokers which you installed in our plant in 1915, we are pleased to advise that they are entirely satisfactory. They have been in daily operation since installation.
>
> Have been the means of saving us sufficient money to yield a good return on our investment, therefore permitting us to use such grades of coal as are not usually dependable and which could not be used under hand-fired boilers."

Detroit "V" type stokers save coal and labor. They will burn the lowest quality coals smokelessly on natural draft up to 200% boiler rating.

We invite consultation with our engineers regarding your specific combustion requirements. Catalog P gives full details.



Detroit Stoker Company

Detroit, Mich.

BRANCHES:

Chicago Cincinnati Pittsburgh Philadelphia Cleveland New York Atlanta Boston

THE STOWE STOKER

EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit.

The Incline Results in Strong Ignition Temperatures

The Stowe Stoker is the *only* conveyor feed built on a decided incline. Every engineer can readily understand the underlying principles of such an incline, and appreciate its great value in producing strong ignition temperatures.

This advantage is particularly apparent in the burning of coals that are hard to light up, because of high moisture or low volatile, such as lignite, coke breeze, river anthracite, and the semi-bituminous coals.

The incline of the Stowe Stoker, because of the (resulting) high bridge wall, vertical flame travel and good furnace arrangement generally, produces very high temperatures at the front of the furnace, causing the incoming coal to ignite with great rapidity and intensity.

Coal will burn only as fast as it can be made to ignite, and *all* stokers have at times their limitations in this one particular. The rate of ignition in the Stowe Stoker, however, *exceeds that of all others*, with the added advantage of a positive, uninterrupted action from coal-hopper to ash-pit.

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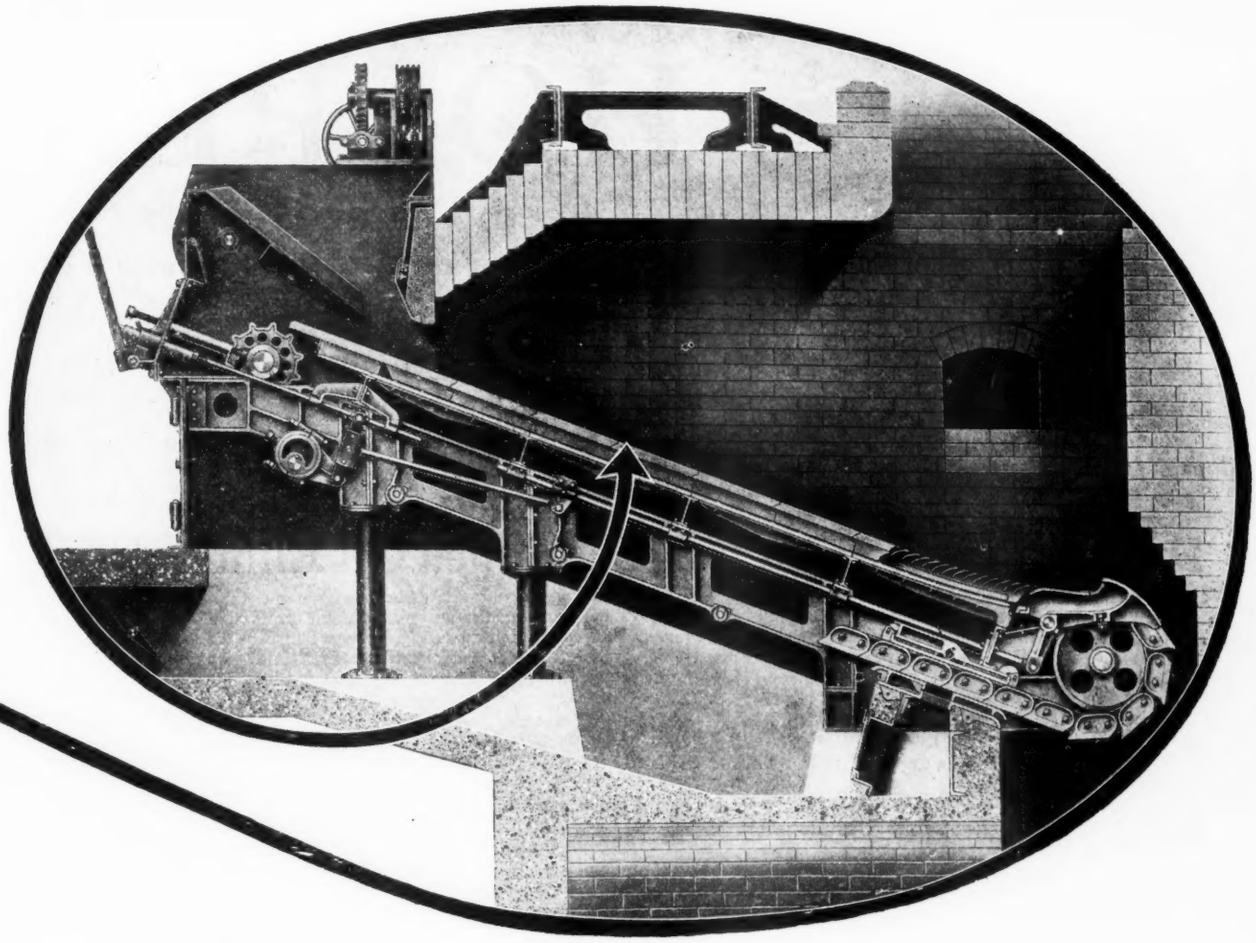

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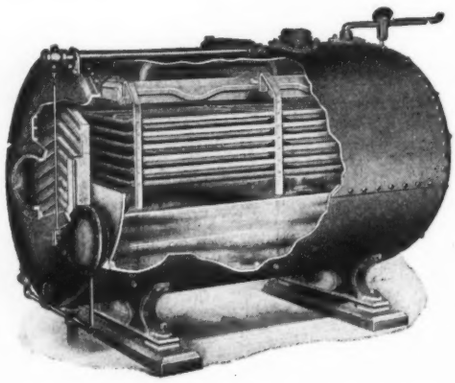

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have a large heating and lime-catching surface which is the most essential feature of any efficient heater. In addition to this they bring the water and steam together in the most effective manner, the water flowing constantly in thin films, in direct contact with the steam, thereby insuring the highest possible temperature and best purification to the feed water. Hoppes Heaters are equipped with large and efficient oil separators and an automatic and accurate feed-water control, and all parts are easy of access and can be readily cleaned and kept in first-class condition. Hoppes Heaters are built in either Steel or Cast-Iron construction and with or without extra water-storage capacity, as may be desired.

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100 Feet Piston Speeds

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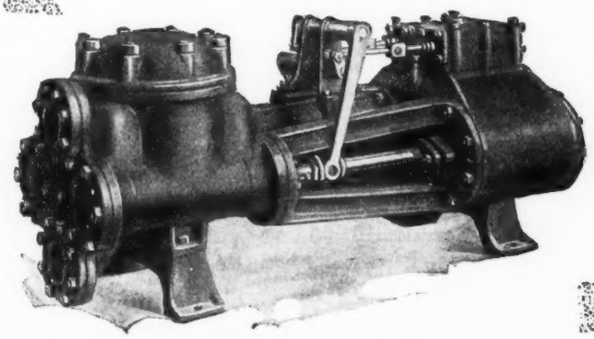

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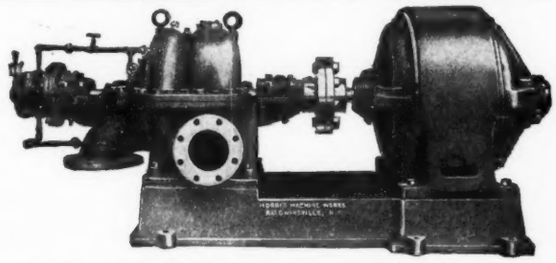

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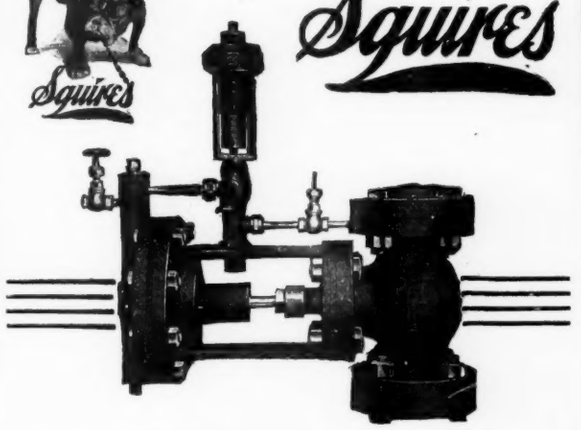

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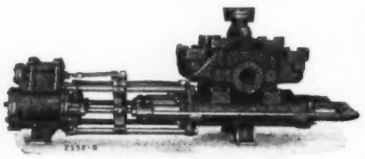

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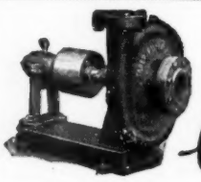

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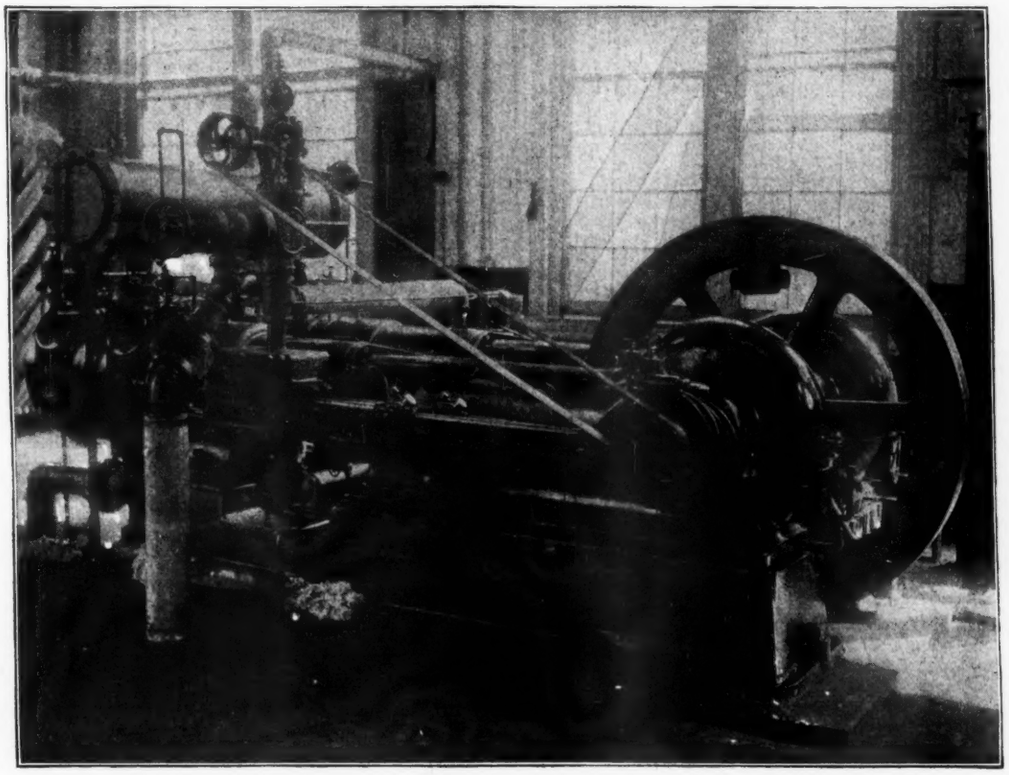

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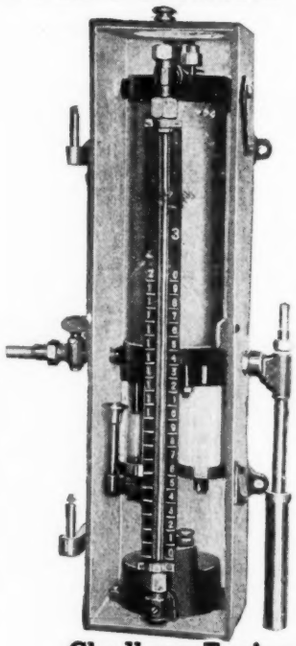

They will quickly learn to appreciate the labor it will save them by watching the reading of the

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This accurate boiler room instrument keeps the firemen posted continuously on the percentage of CO_2 in the flue gases and shows the immediate effect of every adjustment on the combustion efficiency.

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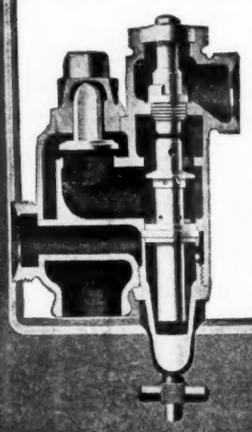

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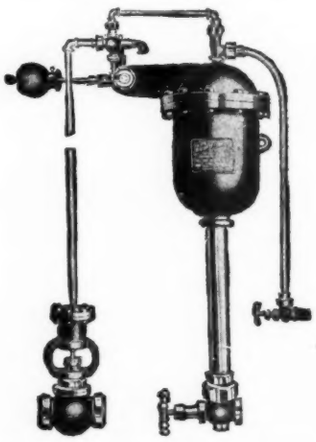

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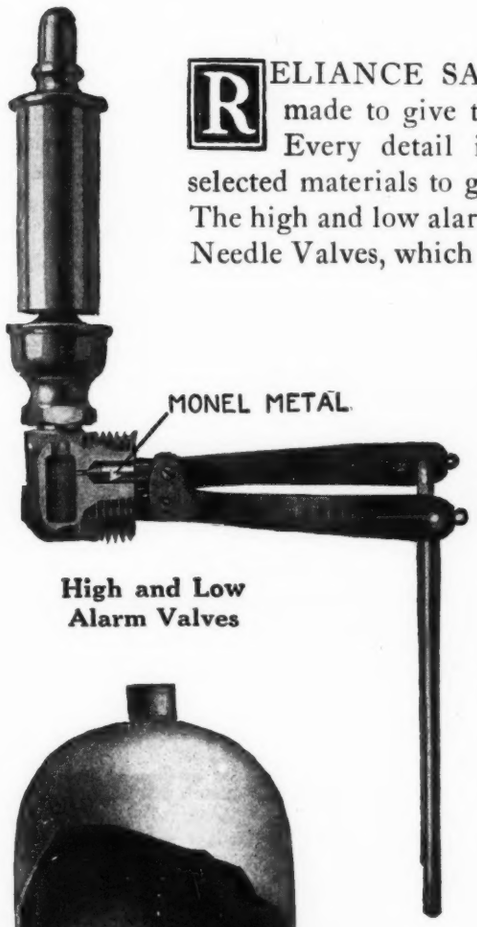

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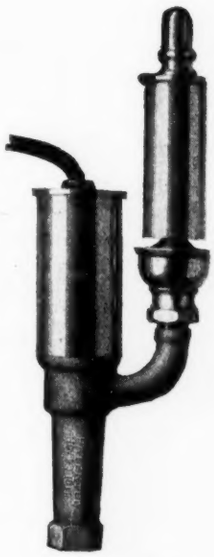

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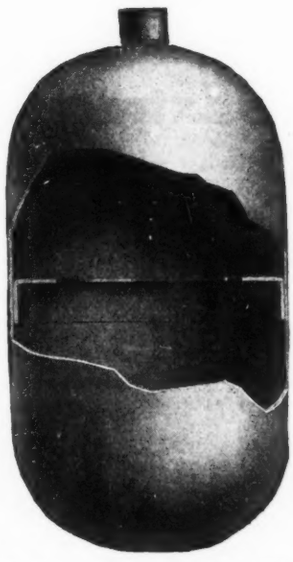

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Reliance Specialties include

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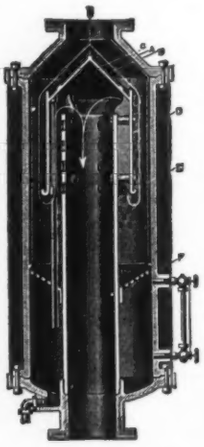

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will deliver steam that is at least 99.8% dry.

They combine capillary attraction with sudden whip snap action to insure the most complete separation of the moisture from the steam. The separated moisture is kept out of the path of the steam and cannot be picked up again.

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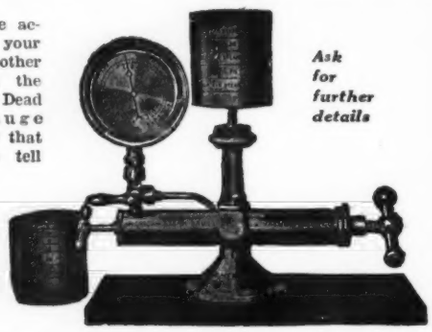

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removes oil and dirt from feed water made up of condensed exhaust and dirty raw water. Reduces coal and water bills. Send for booklet.

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—in place of the so-called "Dry Pipe" insures Steam *free* from mineral matter and *100%* dry by calorimeter test regardless of the load, feed water, or type of boiler.

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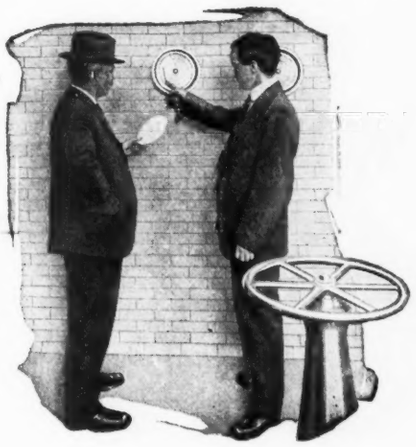
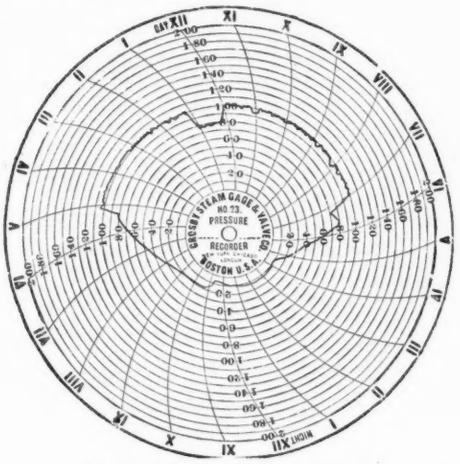
To Know What Pressure Was Carried

There need never be any doubt whether or not the right pressure was maintained on any steam, water, ammonia, gas or air line in your plant.





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CROSBY Pressure Recorders

Patented

will enable you to accurately know the pressure carried at any moment during the day or night.

The continuous records are made on charts graduated for 24 hours or for seven days.

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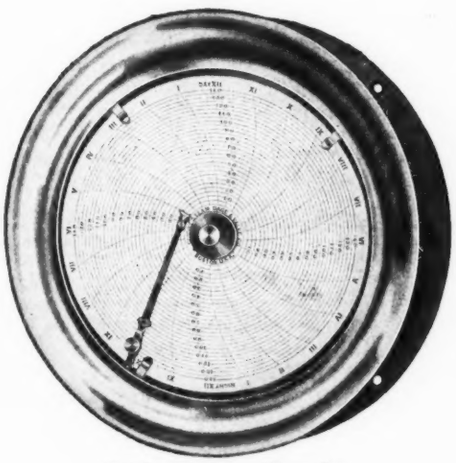
Simple in design. Contains few parts. The accuracy is maintained under heavy duty without constant attention and repairs.

Furnished for any pressure and for vacuum.



Crosby Pressure Recorder

Where a good, dependable instrument is wanted at a somewhat lower price, we recommend our Shawmut Recorders. Ask us to send details.

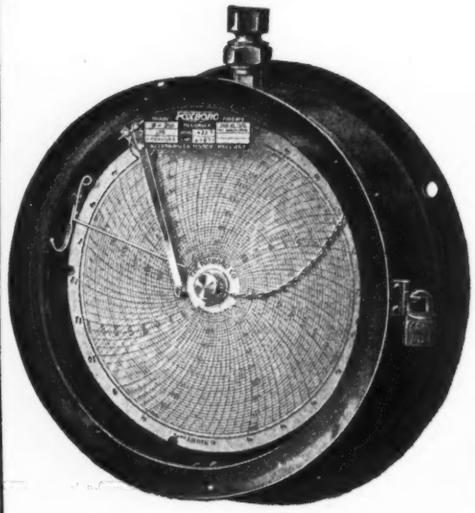
Crosby Steam Gage & Valve Company

Boston New York Chicago San Francisco London

18

STEAM CROSBY SPECIALTIES

STEAM CROSBY SPECIALTIES



Pressure!

FLUCTUATING pressures mean uneconomical firing, damage to boilers through strain, loss in engine efficiency.

Extreme fluctuations mean, on the one hand, insufficient power; and on the other, explosions and various accidents.

A record of pressures made automatically in ink:

Places responsibility;
Shows maximum and minimum pressures;
When they occurred;
When fires were started;
When banked.

FOXBORO
TRADE MARK

RECORDING GAUGES

REGISTER all these facts plainly. They strike the eyes at a glance. No study and no calculations are necessary. There they are to be looked at. They are history, and they form the most powerful stimulus to duty and faithfulness on the part of engineers and firemen.

BESIDES the fact that any carelessness is made evident on the chart, the whole record becomes a guide to more intelligent firing. It is the best and cheapest watchman known. It never sleeps, never makes mistakes. It is a night-and-day power plant record upon which you can rely.

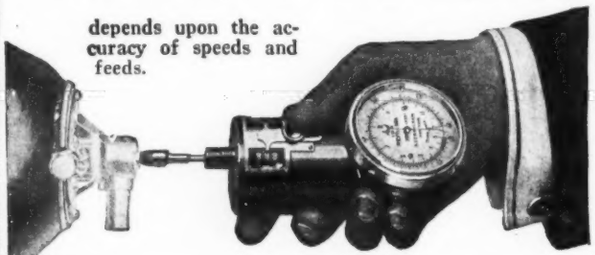
Write for our Recording Gauge Folder E. 121

THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

New York Chicago Pittsburgh San Francisco Birmingham Philadelphia Tulsa St. Louis Peacock Bros, Montreal

Your Plant's Earning Capacity

depends upon the accuracy of speeds and feeds.



30 to 12,000 R.P.M.

O.Z. Tachometers will give you an accurate knowledge of the speed and prevent power waste. They also help to keep your plant's earning capacity at the maximum. *Will you write us?*

O. ZERNICKOW, Park Row Building, New York, N. Y.

To Bring Down Operating Cost

It can be reduced by replacing your present unreliable and inefficient methods of regulation by

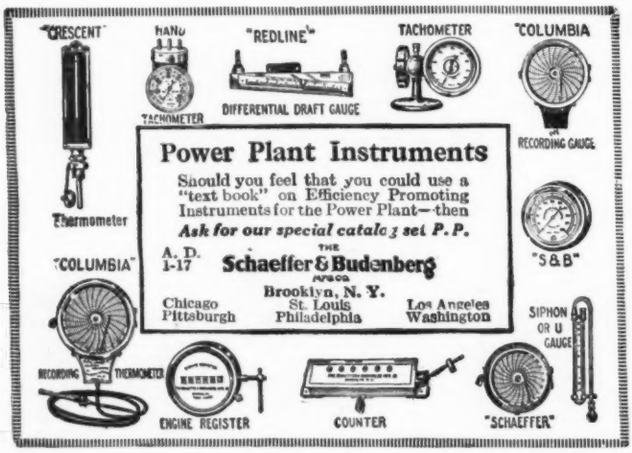
The ARCA REGULATOR

They will automatically enable you to maintain constant steam pressure vacuum, current or voltage and will insure correct boiler feed, etc. Ideal for controlling mechanical stokers.

Our engineering staff would be pleased to investigate your special problem. Full details sent on request.

AMERICAN GALCO INCORPORATED

American Galco, Inc.
Grand Central Palace
New York City



Power Plant Instruments

Should you feel that you could use a "text book" on Efficiency Promoting Instruments for the Power Plant—then *Ask for our special catalog set P. P.*

A. D. 1-17 THE Schaeffer & Budenberg MFG. CO. Brooklyn, N. Y.

Chicago Pittsburgh St. Louis Philadelphia Los Angeles Washington

DUPLEX MONO

Automatic, Continuously Recording
GAS ANALYZING INSTRUMENTS

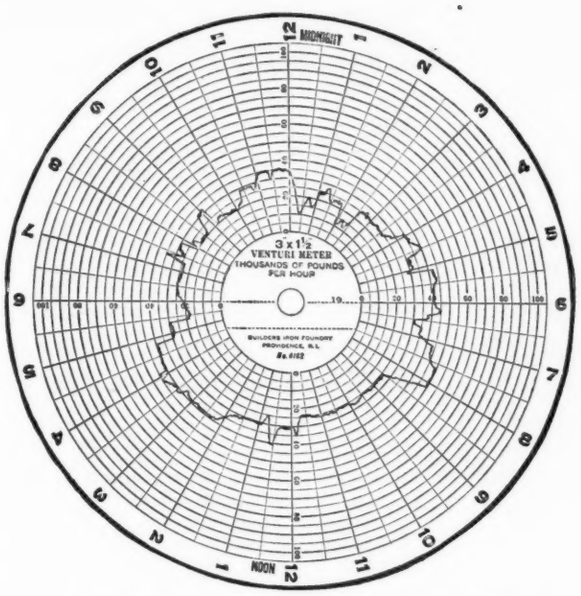
Two records on a single chart, as CO_2 and CO. Also records percentages of O_2, SO_2, H_2, Cl and others.

Mono Corporation of America
25 West Broadway, New York City

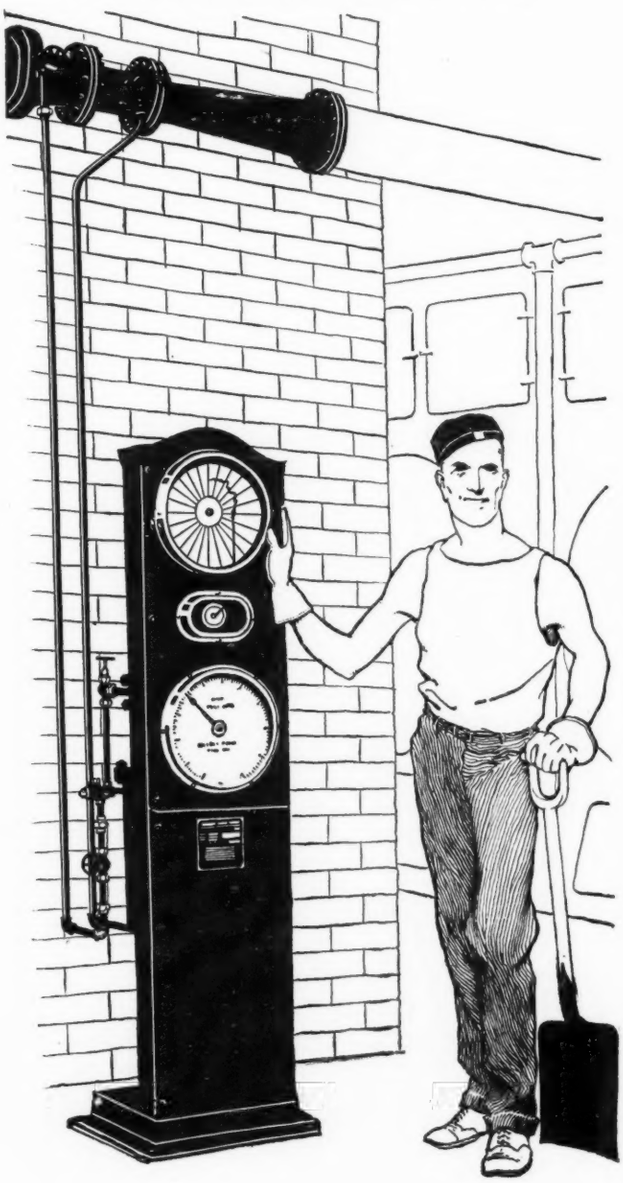
The Low Cost Route from Coal to Power.

SMITH GAS PRODUCERS

SMITH GAS ENGINEERING CO., Dayton, Ohio
Factories: Dayton, Ohio and Lexington, Ohio
Sole Canadian Representatives:
The Canadian Allis-Chalmers Co. Ltd., Toronto



This chart shows economical boiler feeding.



FIRM FRIENDS

The Efficient Fireman and the Venturi Meter!

It is only the lazy and careless boiler tender who has no welcome for the Venturi, since it clearly reveals daily his wasteful methods.

The man who is alive to his employer's interest and who realizes that every possible B.t.u. must be squeezed out of the costly coal pile points with pride to the improvement he has made "since the Venturi was installed."

Every order for a Venturi is a "Stop Loss" Order

Bulletin No. 197, "Why Your Power Plant Needs a Venturi," is Ready.

Builders Iron Foundry

"Builders of the Venturi for 29 Years"

Providence, R. I.

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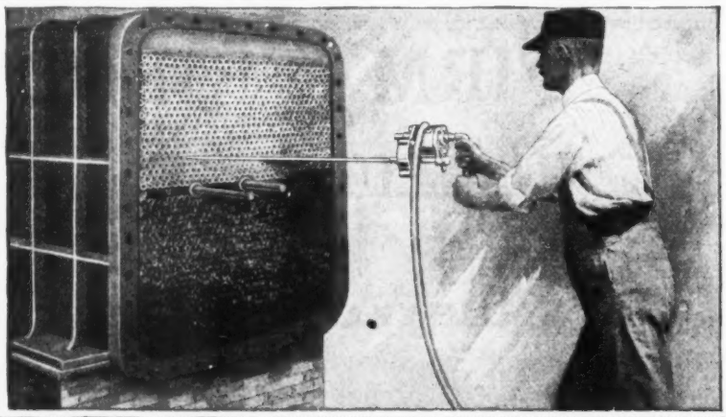


Weighs Less Than 10 Lbs.

No overhead rail, trolley or chain block needed.

THE ROTO CONDENSER CLEANER

Removes all of the incrustations in the shortest possible time and is guaranteed not to damage the tubes in any way.

Driven by compressed air or steam. Full information gladly given upon request.

Write for Catalog

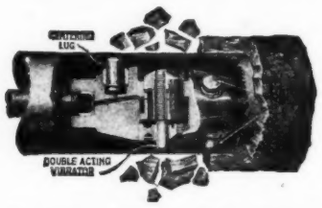
THE ROTO COMPANY
Hartford, Conn.

A Trial Demonstration Cleans One Boiler Free

Here's a proposition where you can't lose. You'll get one boiler cleaned, and *cleaned thoroughly* of scale, whether you like the cleaner or not. Just ask us to send you a straight or curved tube "Demon" (for water tubes), or a "Torpedo" for fire tubes, and try it out on your worst scale-laden boiler. That's all. You'll have the opportunity of trying out the quickest and most thorough tube cleaner you could possibly use.

"Demon" and "Torpedo," friends, are made just that way. Try one at our expense, and at your pleasure.

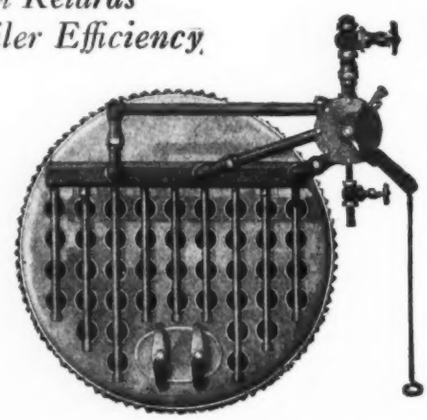
The General Specialty Co. 67 Carroll St. Buffalo, N. Y.



The "Torpedo" Fire Tube Cleaner.

The "Demon" Straight Tube Cleaner.

Soot Retards Boiler Efficiency



Out With It With A "NATIONAL"

SCOUR out the soot in a clean, cool, economical and thorough manner with the NATIONAL Flue Cleaner.

Clean tubes the "National" way and bid farewell to that dirty, dangerous labor and overtime expense. In order that we can name you price, please state number of tubes in each of your return tubular boilers, also state whether uptake is front or rear.

Your request brings particulars.

National Flue Cleaner Co., Inc.
Groveville, N. J.

Cleaner Flues With Less Work

Ruggles "Perfection" Flue Cleaner

are best in the long run, first because of their simplicity. They are light and simple, but strong as the best materials can make them. Work like a plane with a tendency to cut deeper all the time. The long shearing cut gets under the worst incrustations of soot, ash and dirt and leaves the tube perfectly clean. Their flexibility enables them to override flue imperfections such as welds.

Guaranteed to do the work, backed by a record of 16 years' success.

At Your Dealer's, or all sizes shipped from stock. Write for prices and full details.

RUGGLES & RUGGLES - - - Batavia, Ill.

FOR DRY STEAM

Guaranteed 99.5% dry regardless of length of the steam line with

WYOMING AUTOMATIC ELIMINATORS

They combine a high quality separator with a trap in a single piece of equipment

W. H. NICHOLSON & CO.
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Erfmann's Boiler Water Controller

a device which the man in the boiler room can use, points to

THE WAY TO PREVENT BOILER SCALE

It tells in a simple test taking only a few minutes, just the amount of soda ash that should be added to your boiler water to prevent incrustation. Write for details.

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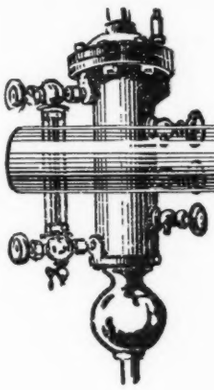


The Thrift Twins—

"The Unbreakable Boiler Gauge Glass'

AFTER you have once equipped your plant with SONDERGLASS you are through with those frequent gauge glass renewals. It is scientifically made of two semi-metallic substances which withstand all sudden abnormal temperature changes.

It can be exposed to cold drafts, splashing with ice cold water when hot or superheated steam when cold—the result is always the same — IT'S "UNBREAKABLE."

Sonderglass will remain clear throughout its life, *adds to safety,* and *may save your eyesight* from flying glass!

"COMBINATION" Scraper and Brush

Trade Mark Reg.

The genuine bears the name CHESTERTON on each hollow nut.

This scraper is two boiler cleaning tools in one.

It brushes as it scrapes as it cleans.

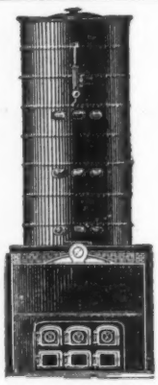
Gets *all* the soot out —without harm to the tubes.

Saves time — saves labor. A real thrift tool.

Results are what tell the story in dollars and sense.
Try the Thrift Twins and watch your plant expenses decrease.

A. W. CHESTERTON COMPANY

64 India Street, Boston, Mass.



Steel Cased Setting Increases Efficiency.

Wickes Vertical Water Tube Boiler

Have you seen the STEEL CASED SETTING for enclosing this boiler?
Air infiltration losses are overcome.
The highest possible thermal efficiency results.

Ask for bulletin—Magnitude and Prevention of Air Infiltration Losses—sent free

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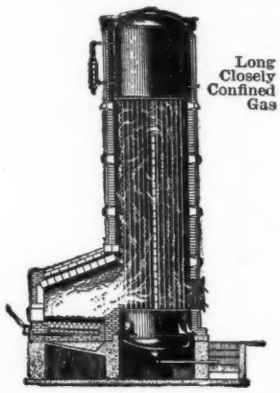
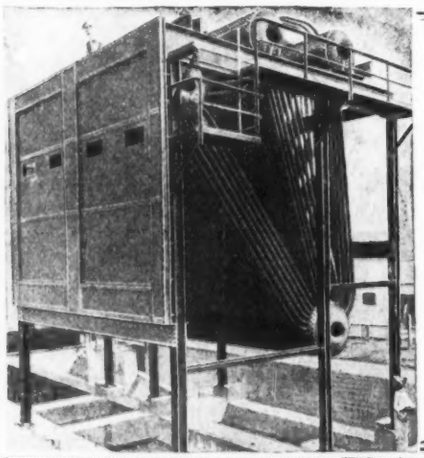


Long Closely Confined Gas



This picture shows a 1058-H.P. unit at Andrews Steel Co., Newport, Ky.

Connelly Water Tube Boilers

(Patented)

are of the 4-drum type, have 100 per cent. tube area in the path of the circulation, and deliver steam slightly superheated. Simple in design, have no flat surfaces, no stay-bolts, and free from hundreds of joints (no handholes). Easily accessible for cleaning internally and externally. Can be built in units up to about 4000 hp.

Write for copy of our new Catalog. (Desk 4)

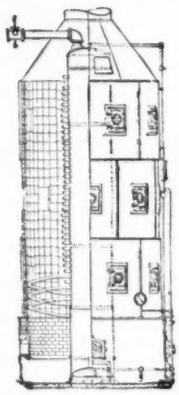
The D. Connelly Boiler Co., Cleveland, Ohio

Founded in 1875 by Daniel Connelly

MORRIN-CLIMAX Vertical Tube Boilers are economical, because of the greater steaming power obtainable in a small space. The perfect transfer through the tubes makes it easier to raise steam and maintain it.

Write for further details.

Morrin-Climax Boiler Co.
Jersey City, N. J.



THE EDGE MOOR WATER TUBE BOILER

Especially Suitable for Large Power Plants

Steel construction throughout. Straight tubes. All hand-holes elliptical, their covers internal and removable through their own openings. Unrestricted circulation permitting forcing of fires with safety and economy.

Send for Bulletins on Performance

EDGE MOOR IRON COMPANY

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Established 1886

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Horizontal Return Tubular Boilers
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SECTIONAL
ALL STEEL

Springfield Boiler Co.
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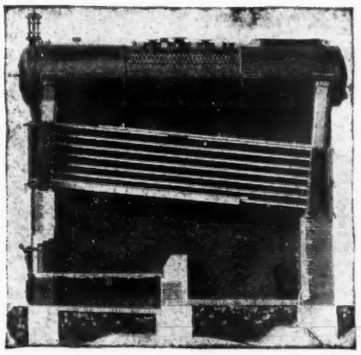
ERIE CITY IRON WORKS
HORIZONTAL WATER TUBE BOILER



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IN 1898
STEAM SUPERHEATERS

Were introduced commercially in the United States by this Company. Owners of boilers it has built—Babcock & Wilcox, Stirling and Rust—not now equipped with these coal-saving accessories can obtain information about superheating possibilities from the nearest office listed below.

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NEW ORLEANS, 533 Baronne Street
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LOS ANGELES, 404-406 Central Bldg.
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S. O. S.
Story of Steam
A $2,000,000 Order
for Parker Downflow Boilers, because they never killed anyone.
SAVE LIVES SAVE COAL
Pardel Corp., Bailey Bldg., Philadelphia, Pa.

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Two boilers in one; criss-cross tubes give double capacity. Entirely enclosed in airtight steel casing; no brick settings. Oscillating soot blower standard equipment. Also manufacturers of waste heat boilers. For complete catalog write the Page Boiler Co., 817 Larrabee St., Chicago, Illinois.

For Higher Efficiency
UNION
Water-Tube Boilers

Provided with self-contained feed water purifier that positively minimizes scaling. Very rapid circulation and free steam release. High overload capacity. Write us for full details.

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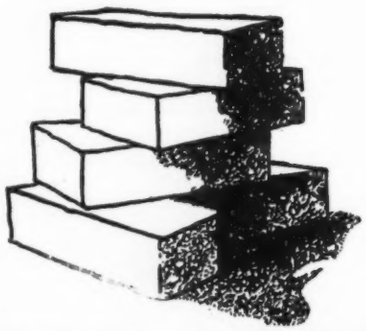
Erie, Pa.



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High Temperature Cement

Bondite scientific refractory furnace cement is made up in different grades for different requirements. Bondite quality cement *plus* Bondite scientific service will make your fire brick last from 2 to 5 times longer.

Free Booklet on Request

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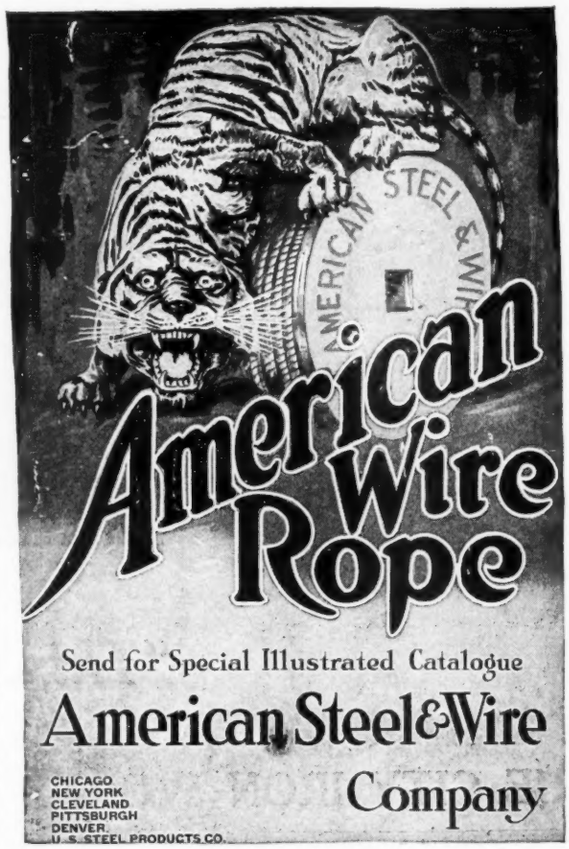

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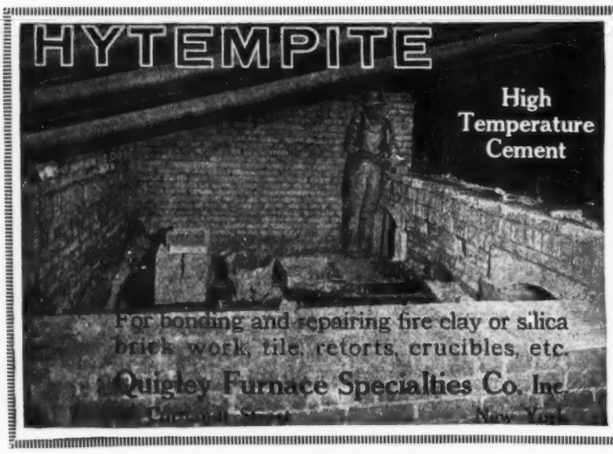
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High Temperature Cement
For bonding and repairing fire clay or silica brick work, tile, retorts, crucibles, etc.
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Avert Accidents

In other words, figure your Friction Clutch installations with these books.

The books are *sent free on request.*

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RADIAL BRICK AND REINFORCED CONCRETE
REFRACTORY BRICKWORK

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"TAYCO"—*A Scientific*—FIRE BRICK

A new refractory for high and sudden changes in temperature. Makers also of fire clay brick, baffle tile, fire door arches and jambs, etc.

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There is No Better Furnace Lining

PLIBRICO
JOINTLESS
FURNACE LINING

Showing Ease With Which Plibrico Is Laid in Place

PLIBRICO has been developed as a plastic furnace lining that can be shaped in place and afterwards vitrified to make a one-piece monolithic lining—*than which there is no better setting for any industrial boiler.* It has been the one and only ambition of the Jointless Fire Brick Co. to serve well not only with a view of profit, but from an altruistic angle and a real desire to *serve* at the gate post, *where economy begins* in every boiler plant — in the boiler furnace lining.

And when it comes to baffles—horizontal and vertical, any type of boiler, let us supervise your first installation and you will put in your own baffles without any further help ever after

Old boiler settings are reborn by patching with Plibrico.

Shipped in steel containers. Warehouse stock carried in all principal cities for immediate deliveries.

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Jointless Fire Brick Co.

Manufacturers of Plibrico

Offices and Factory
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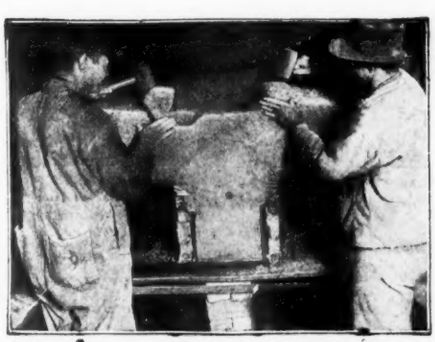
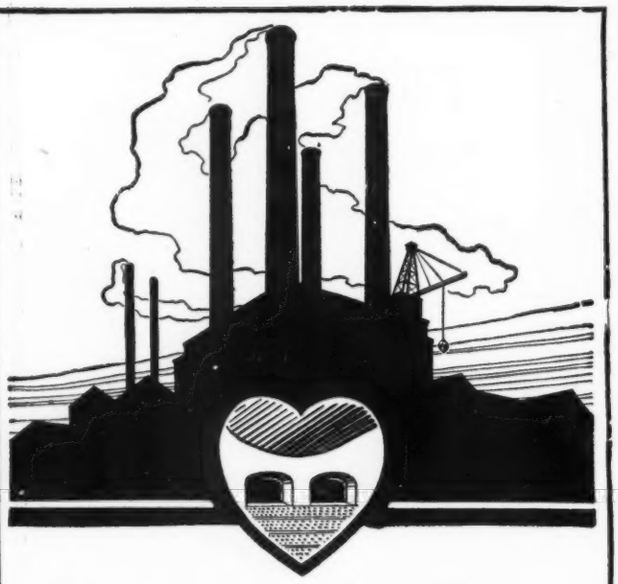


Plibrico Is Easily Moulded to Fit Any Place



Permanent One-Piece Arches and Furnace Walls

that keep out cold air, need no repairs and prevent boiler shutdowns, are quickly installed by using

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REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF.

Your own workmen pound the plastic material into position with mallets, smooth it off with trowels, harden it with a few hours heating and then fire up the boilers and your plant is good for years of efficient service.

Here's a modern furnace construction and repair material that does away with fire brick and its cracks and crumbling arches. Your walls stand for years instead of months a hopeless barrier to chilling currents of outside air.

You want our booklet on furnace wall construction. It's concise, instructive and complete. Say the word and we'll send it by return mail—you'll be glad you did it.

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Cuts Down the Coal Bill

Stops air leaks in your boiler settings—thus effecting a *coal saving* of from 3 to 10 per cent.

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MEXICO, MISSOURI

Why do I Smile? READ THIS

"Year before last we had ordinary arches. Twice they broke down when our load was at its peak. That meant two shutdowns just when time meant most to us. You can bet I didn't smile, then!

"I finally got the boss to install

Liptak Double Suspension Arches

so this wouldn't happen again.

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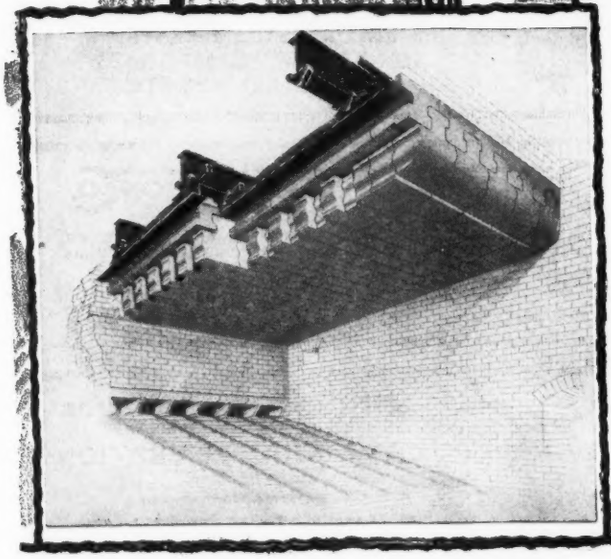

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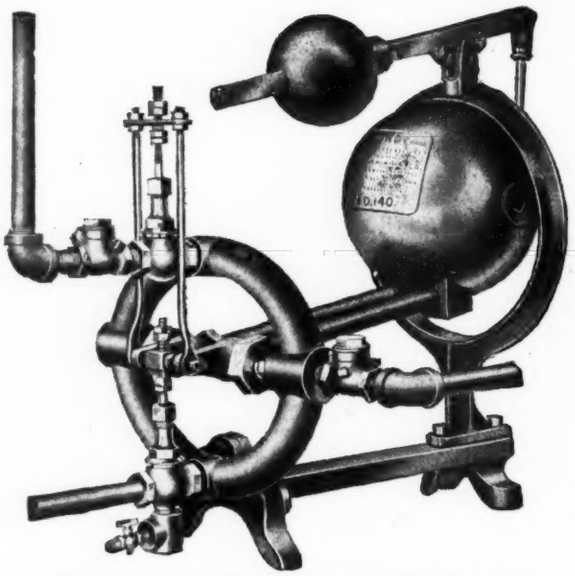

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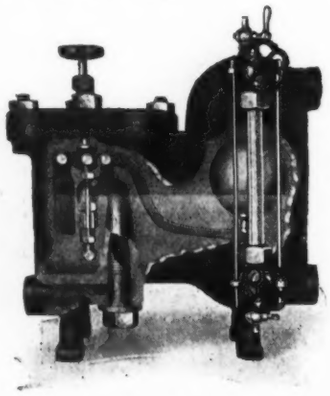

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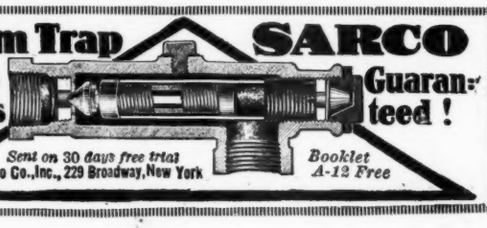

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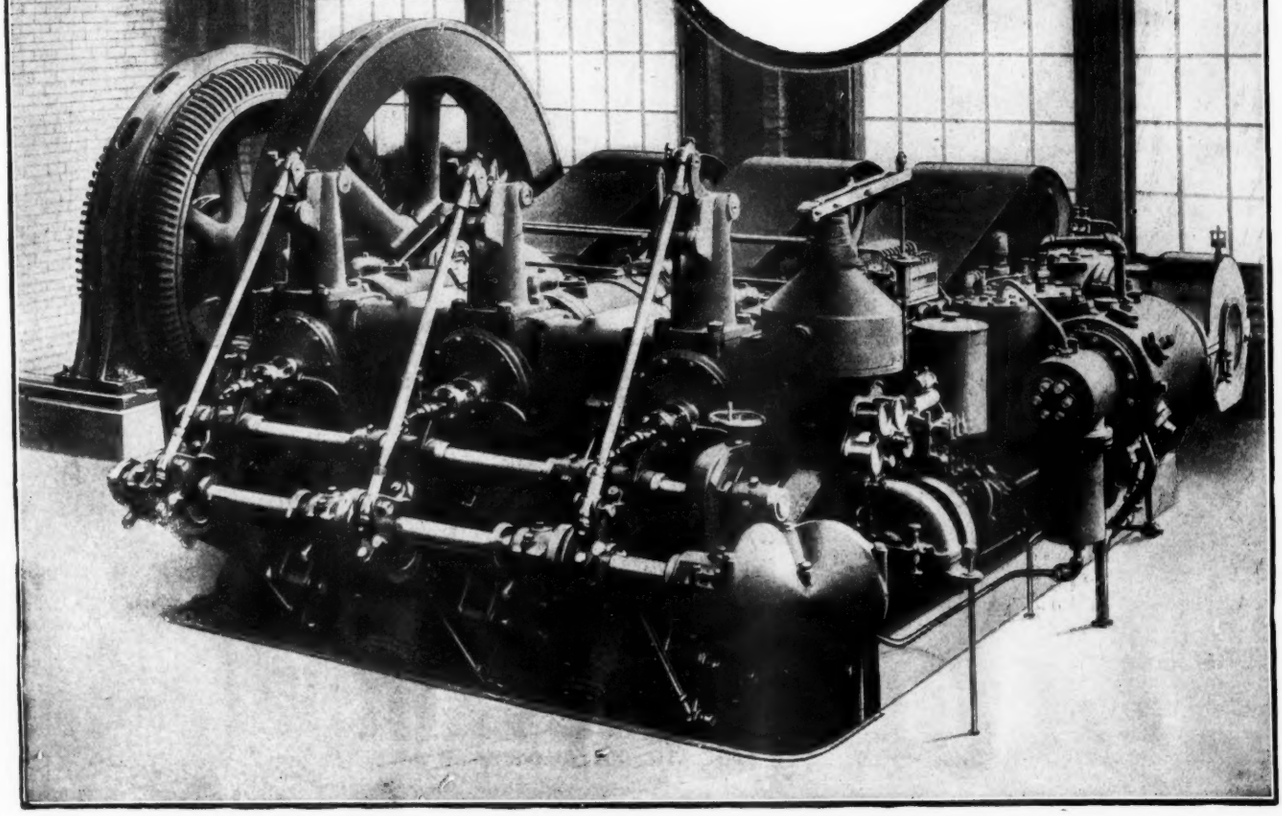

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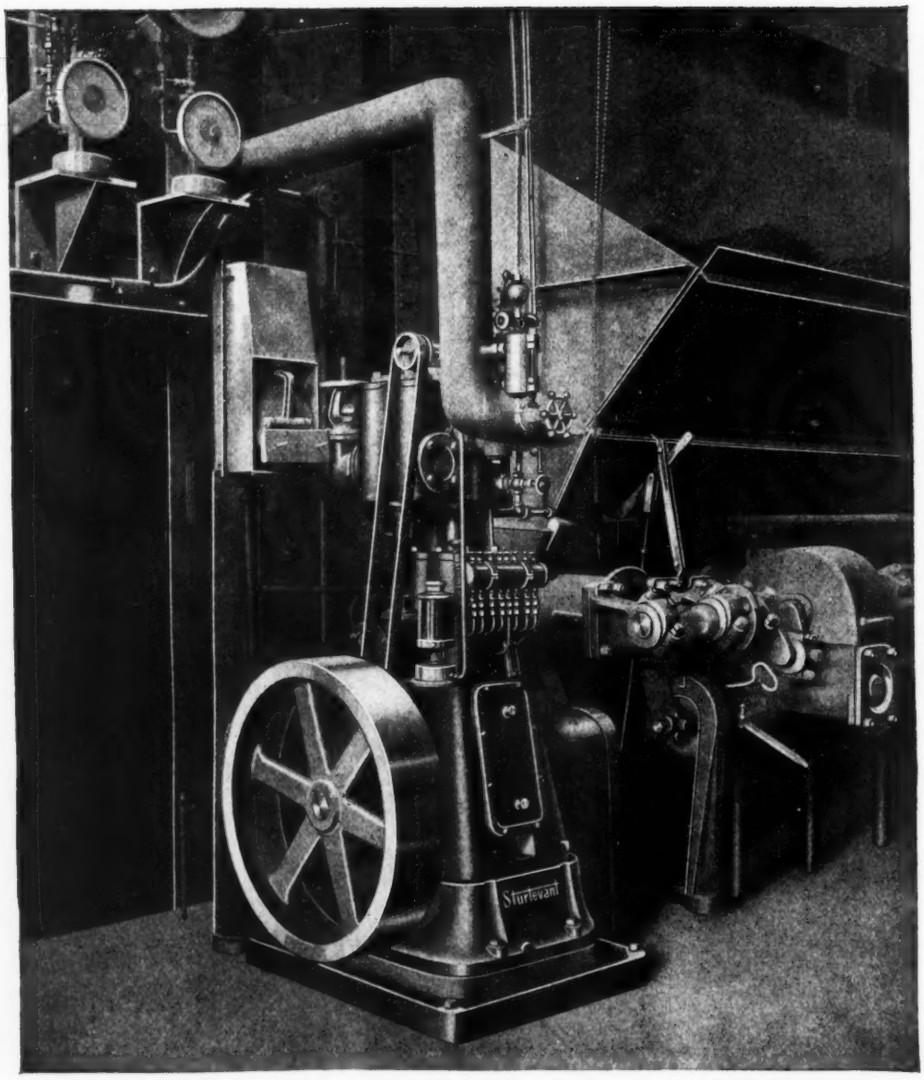

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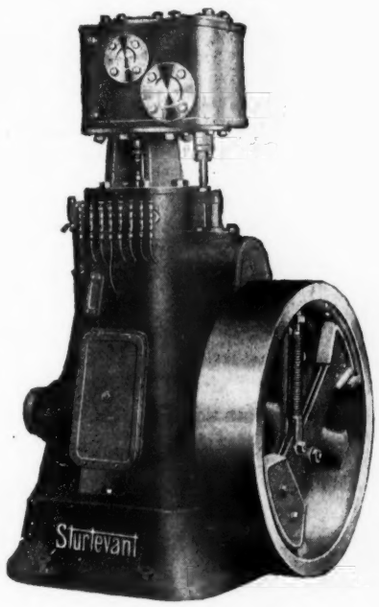

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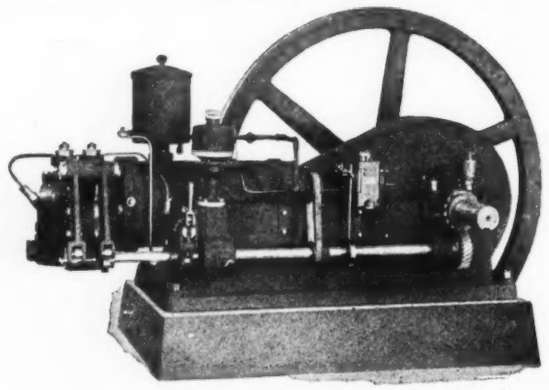

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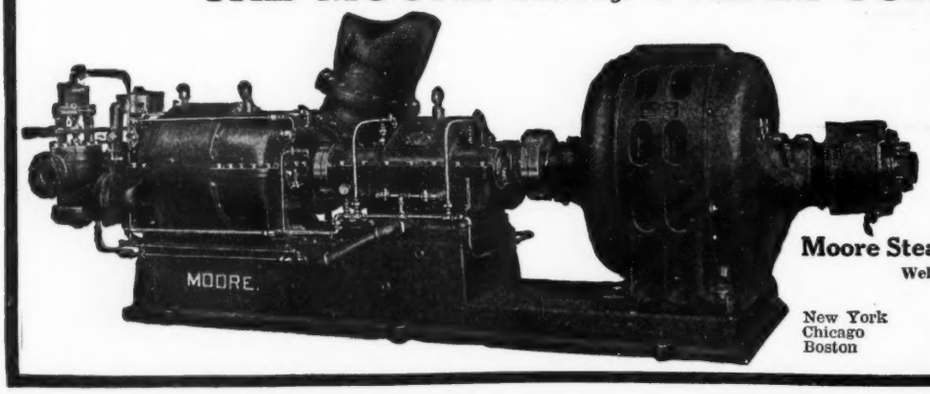

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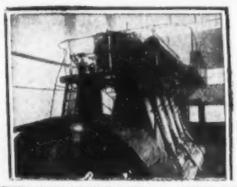

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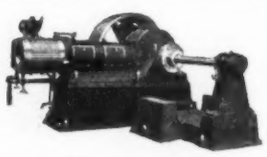

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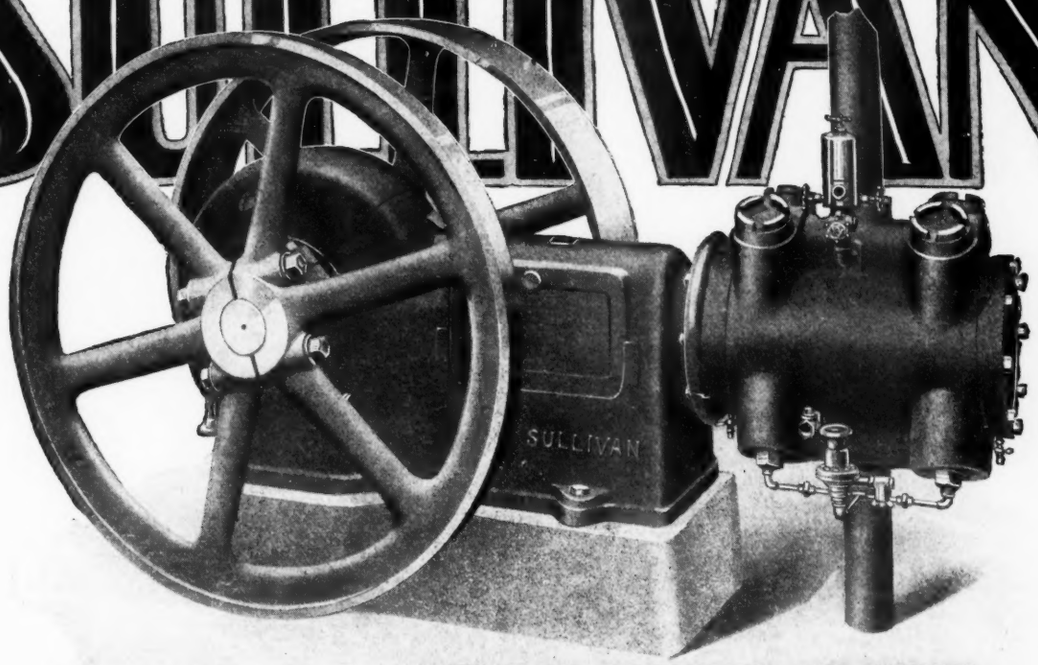

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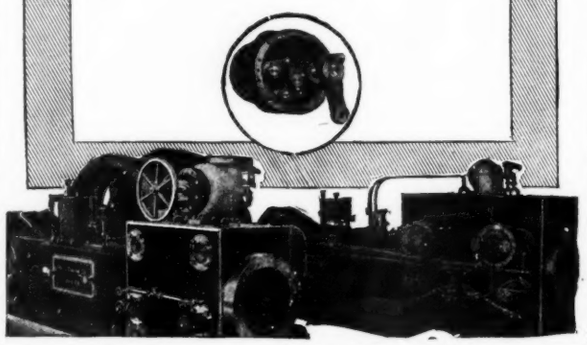
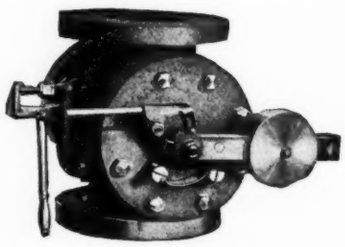


For Safety



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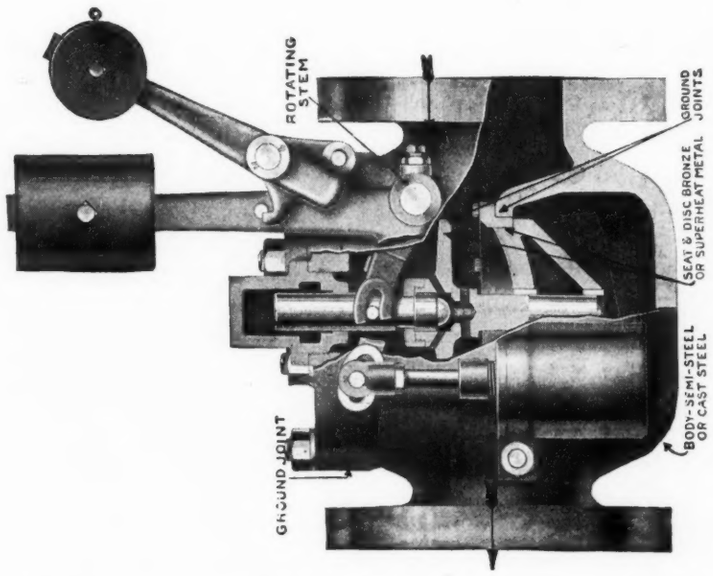

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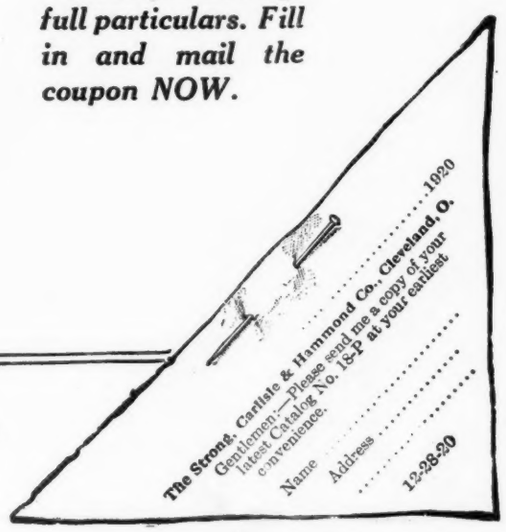
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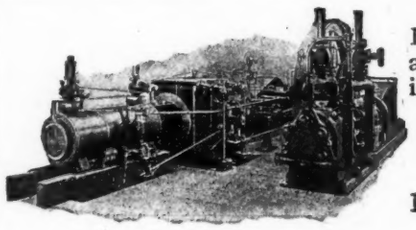

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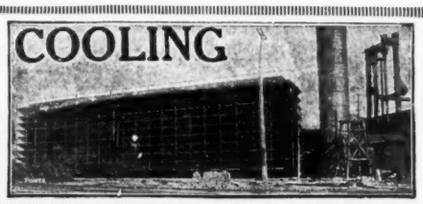

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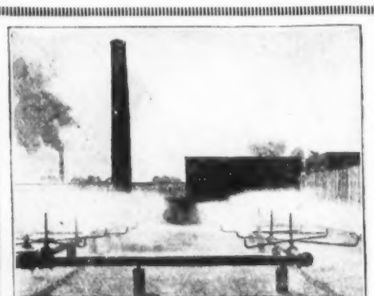

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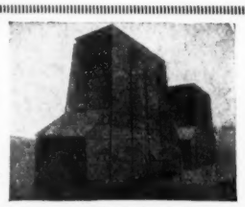

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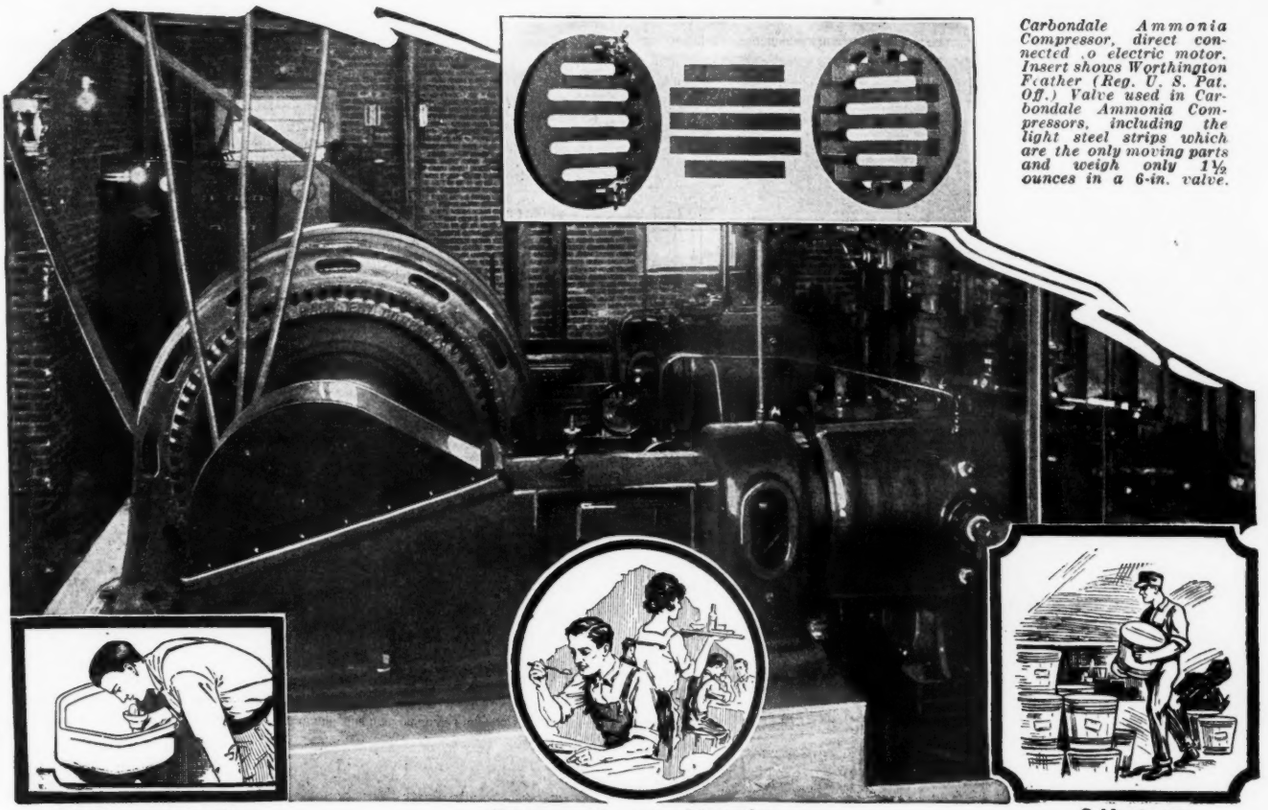

Carbondale Ammonia Compressor, direct connected to electric motor. Insert shows Worthington Feather (Reg. U. S. Pat. Off.) Valve used in Carbondale Ammonia Compressors, including the light steel strips which are the only moving parts and weigh only 1½ ounces in a 6-in. valve.

Drinking water cooling

Factory restaurant refrigeration

Cold storage

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The ammonia compressor used in this system stands up under the high rotative speeds; direct connected to electric motors or high efficiency steam and oil engines. The reason for this is the Worthington Feather (Reg. U. S. Pat. Off.) Valve which overcomes the only obstacle that limited the speed of ammonia compressors in the past—the old style valves.

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Model 310
Portable Single-Phase Wattmeter

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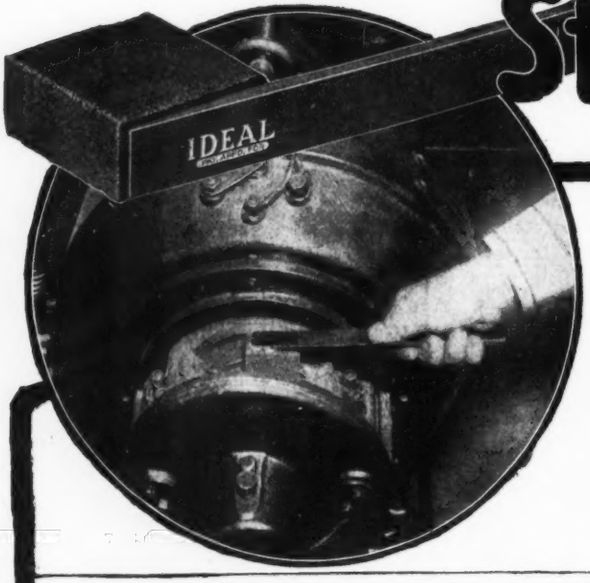
Stops Sparking



Here's a simple and effective means of stopping sparking and loss of power on your small generators and motors. A few moments spent occasionally in applying an

Ideal Commutator Resurfacer

against your commutators will do the trick. The Ideal is a manufactured abrasive block of uniform cutting quality—*not* a natural stone of unequal density. It smooths down high mica and ridges, and thereby stops sparking, prevents loss of power and increases the life of the equipment. It is being used daily on thousands of small as well as large machines. It affords a quick and inexpensive means of putting your equipment in fine condition and keeping it that way at all times and under all operating conditions. There is an IDEAL RESURFACER to suit any size of equipment.

Our Free Trial

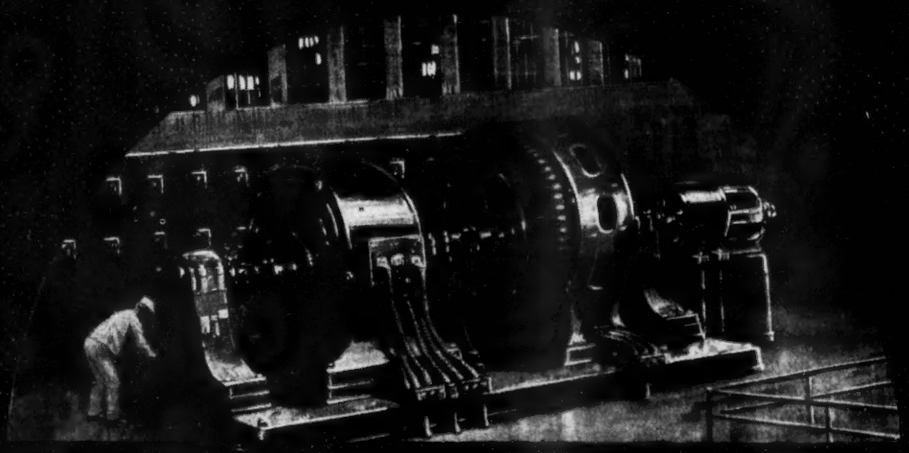
Take advantage of our free trial offer of an IDEAL COMMUTATOR RESURFACER. Try one out for yourself. If you don't feel satisfied with it return it C. O. D. Mail in the coupon today. You will not in any way be obligated.

Ideal Commutator Dresser Company
3225 Sheffield Ave. Chicago

IDEAL COMMUTATOR DRESSER CO. P 12-28-20
3225 Sheffield Ave., Chicago

Gentlemen: Please send me an Ideal Commutator Resurfacer for free trial. It is understood that if I am not fully satisfied with it I will return it at your expense. I want to use it on equipment as follows:

Approx. R. P. M. ..... Diameter of Commutator .....
Approx. width of Commutator .....
Approx. distance between brush sets ..... Condition .....
My name is ..... Position .....
Company .....
Company address .....
City ..... State .....



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Economy Fuse performance is a matter of record—they were the first fuses using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be *Approved in All Capacities* by the Underwriters' Laboratories.

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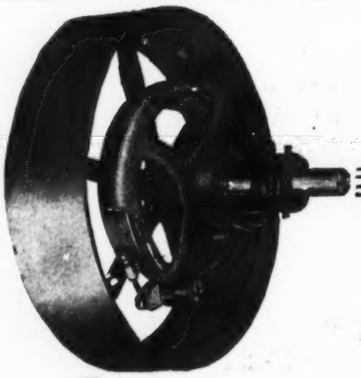
Economy Fuses are also made in Canada at Montreal



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It's the years of satisfactory, uninterrupted service that determines the true economy of a clutch—not the original cost.

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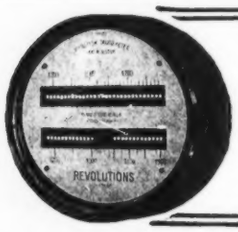

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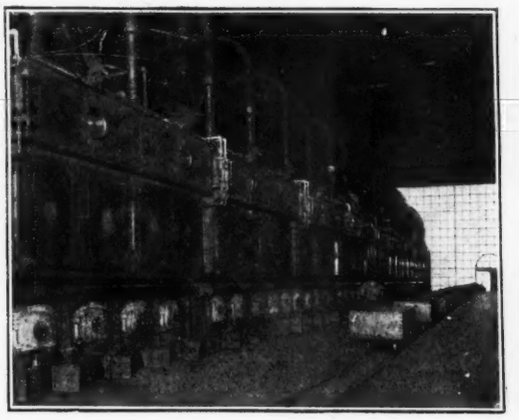

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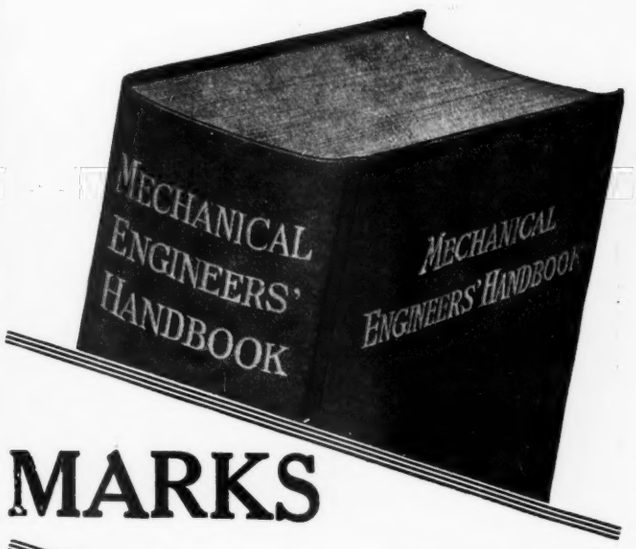

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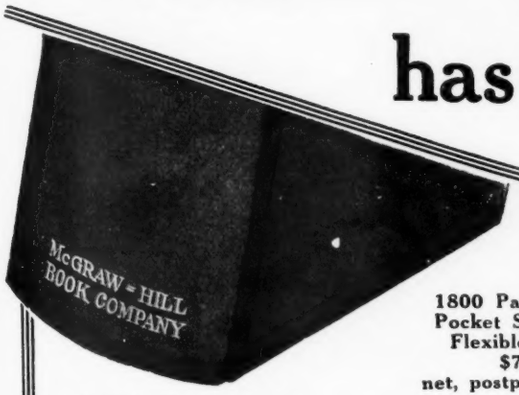

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Equipment, Apparatus and Supplies Used in the Power Plant Field with Names of Manufacturers and Distributors

Please refer to the Buying Section for addresses of concerns listed in this directory.
See Last Page for Alphabetical Index

Air Aftercoolers and Receivers
Biggs Boiler Works Co.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co
Lancaster Iron Works

Air Compressors
Allis-Chalmers Mfg. Co.
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Elliott Company.
Griscom-Russell Co.

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Ridgway Dynamo & Eng. Co.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.

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Weston Elec. Inst. Co.

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(See Boiler Arches and Setting)

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Gen'l Asbestos & Rubber Co.
Johns-Manville

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(See Gates Bin)

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(All Coal and Ash Handling Machinery)

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Gillis & Geoghegan

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Green Engr. Co.

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Green Engineering Co.

Ash Tanks, Steel
Heine Safety Boiler Co

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Engineer Co.

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Bound Brook Oilless Bearings

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Belt Dressing
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Ladew Co., Inc., E. R.
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N. Y. Belting & Packing Co.
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Rhoads & Sons, J. E.
Schieren Co., Charles A.
United States Rubber Co.

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Dominion Asbestos & Rubber Corp.

Belting, Canvas Stitched
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Schieren Co., Chas. A.

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Clarage Fan Co.
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Johns Manville Co.
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McLeod & Henry
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Chicago Chemical Co.
Dearborn Chemical Co.
Dixon Crucible Co., Jos.
Hawkeye Compound Co.
McLeod & Henry
Perolin Co. of America

Boiler Feed Pumps
(See Pumps, Boiler Feed)

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Permutit Co.

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Yarnall-Waring Co.

Boiler Tube Cap Reseating Machine
Lagonda Mfg. Co.

Boiler Tube Cleaners
(See Blowers Soot)
(See Scale Removers)

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Cruise & Co.

Boiler Tube Welding
McEwen Bros.
General Specialty Co., The

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Amer. Tube & Pipe Bend. Co.
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Casey-Hedges Co., The
Fitzgibbons Boiler Co.

Boilers, Return Tubular
Bigelow Co., Philadelphia
Coatesville Boiler Works
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Babcock & Wilcox Co., The
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Casey-Hedges Co., The
D. Connelly Boiler Co.
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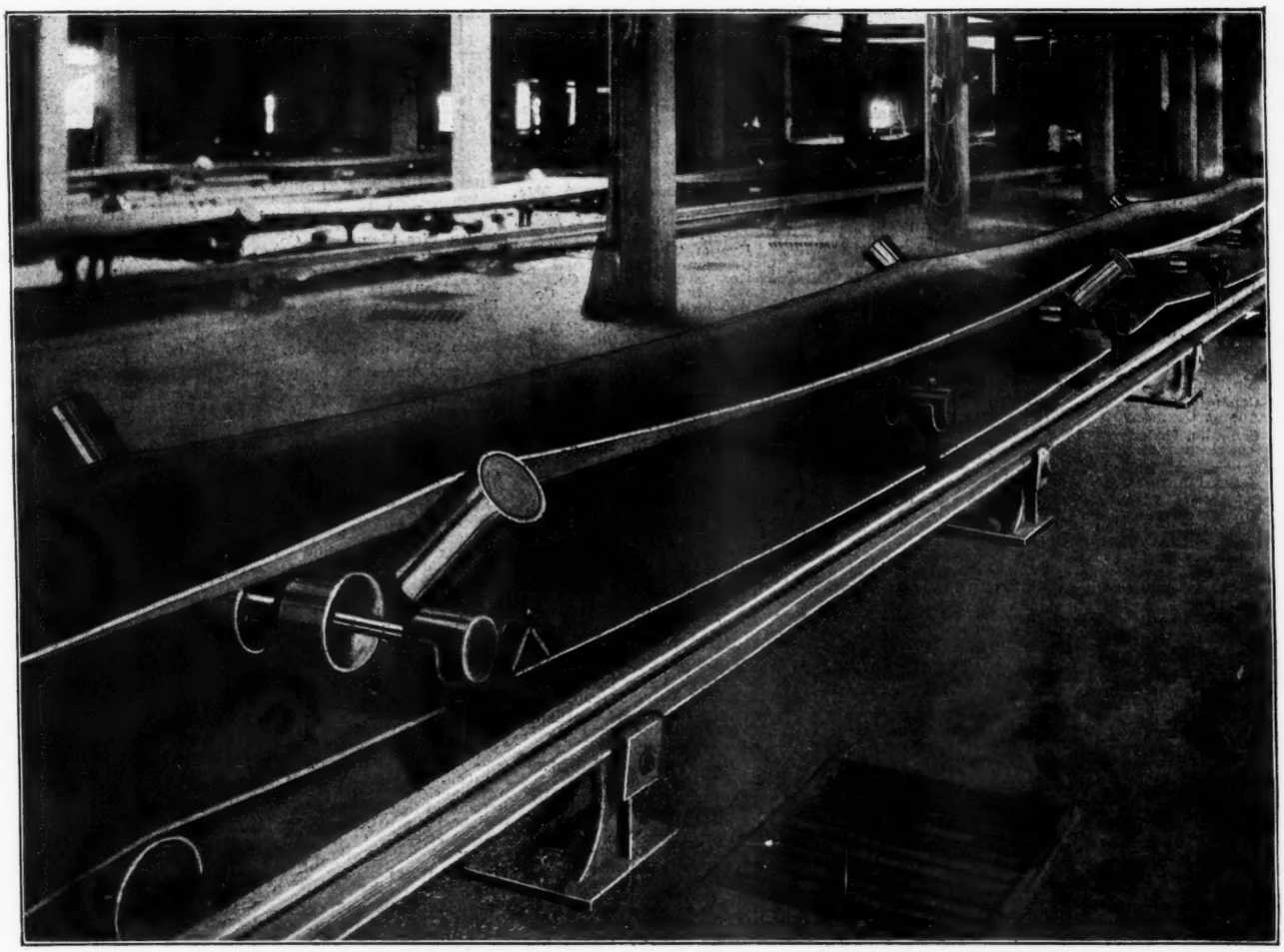

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C. H. Wheeler Mfg. Co.

Condensers, Surface
Ingersoll-Rand Co.
Wheeler Cond. & Eng. Co.
C. H. Wheeler Mfg. Co.
Worthington Pump & Machy. Corp.

Condensation Meters
(See Meters)

Condensation Pumps
See Pumps)

Connecting Rods
Williams & Co., J. H.

Connectors, Frankel Solderless
Westinghouse Elec. & Mfg. Co.

Conduit Elbows
Am. Tube & Pipe Bend'g Co.

Conduits, Electrical
Adapti Company

Conduits, Underground
American Dist. Steam Co.

Controllers, Boiler
Kelley Controller Co.

Controllers, Electric
Brown Instrument Co.
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Controllers, Feed Water
(See Feed Water Regulators)

Conveyors, Belt
Barber Greene Co.
Beaumont Co., R. H.
Chain Belt Co.
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
Guarantee Construction Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Portable Machinery Co., Inc.
United States Rubber Co.

Conveyors, Cable
Lancaster Iron Works

Conveyors, Clinker and Cinder
(See Coal and Ash Handling Machinery)

Conveyors, Coal and Ash
(See Coal and Ash Handling Machinery)

Coolers
Carbondale Machine Co.
Griscom-Russell Co.

Coolers, Inter and After
Alberger Heater Co.
Schutte & Koerting Co.

Coolers, Oil
Alberger Heater Co.
Schutte & Koerting Co.

Cooling Plants and Ponds
Badger & Sons Co., E. B.
Cooling Tower Co.
Spray Engineering Co.
Star Brass Works
Yarnall-Waring Co.

Cooling Towers
Badger & Sons Co., E. B.
Burhorn Co., Edwin
Carbondale Machine Co.
Cooling Tower Co.
De La Vergne Mach. Co.
Wheeler Mfg. Co., C. H.
Wheeler Cond. & Engr. Co.
Worthington Pump & Mchy. Corp.

Couplings, Direct Connected
Karge-Baker Co.

Couplings, Flexible Shaft
Chain Belt Co.
Chas. P. Bond Co.
Dexter Co., I. H.
Karge-Baker Co.
Smith & Serrell

Couplings, Friction Coil
Karge-Baker Co.

Couplings, Rigid
Smith & Serrell

Couplings, Shaft
Dexter Co., I. H.
Karge-Baker Co.
Smith & Serrell
W. H. Nicholson & Co.

Covering, Boiler Setting
Betson Plastic Firebrick Co.
Excello Mfg. Co.
Jointless Fire Brick Co.
The Paul B. Huyette Co.
Obermayer Co., The S.

Covering, Pipe and Boiler
Johns-Manville
Magnesia Assn. of America
Ric-Wil Co.

Covering, Underground Steam Pipe
Johns-Manville, N. Y.
Ric-Wil Co.

Cranes
Brown Hoisting Mach. Co.
Chas. P. Bond Co.
Godfrey Conveyor Corp.
Link-Belt Co.
Orton & Steinbrenner Co.
Shepard Electric Crane & Hoist Co.

Crankpin Turning Machines, Portable
Underwood & Co., H. B.

Crankshafts
Williams & Co., J. H.

Crankshaft Repairs
Metal & Thermit Corp.

Cutting Oil
The Sun Co.

Cut-Outs, Electric
Chicago Fuse Mfg. Co.
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Cutters, Boiler Tubes
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Rooksby & Co., E. J.
Underwood & Co., H. B.

Cylinders, Compressed Air, Gas, Etc.
Nat'l Tube Co.

Dashpots
Farnsworth Company
Underwood & Co., H. B.

Dealers
(See Searchlight Section)

Die Stocks
Armstrong Mfg. Co.
Curtis & Curtis Co.
Toledo Pipe Theading Mach. Co.

Distilling Mchy. & Apparatus
Whitlock Coil Pipe Co.

Distilling Plants (Water)
Griscom-Russell Co.

Draft, Mechanical
(See Blowers, Fan)

Drills
Barnes Co., W. F. & John
Chicago Pneumatic Tool Co
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Terry Steam Turbine Co.

Drop Forgings
Williams & Co., J. H.

Dust Collectors
Clarage Fan Co.
Sturtevant Co., B. F.

Dynamos (See Generators)

Economizers, Fuel
Green Fuel Economizer Co.
Sturtevent Co., B. F.

Ejectors
American Injector Co.
Chaplin-Fulton Mfg. Co.
Eynon-Evans Corp.
Lunkenheimer Co.
Manning Maxwell & Moore, Inc.
Penberthy Injector Co.
Schutte & Koerting Co.

Electric Wires and Cables
American Steel & Wire Co.

Elevators and Conveyors
Beaumont Co., R. H.
Jeffrey Mfg. Co.
Link-Belt Co.
Orton & Steinbrenner

Elevators and Elevator Service
Otis Elevator Co.

Engineering Service
(See Directory)

Engine, Hoisting
Nordberg Mfg. Co.

Engine Repairs
Lammert & Mann Co.
Rooksby & Co., E. J.
Underwood & Co., H. B.

Engine Stops
Jenkins Machine Co.
Schutte & Koerting Co.
Strong Carlisle & Hammond Co. The

Engines, Diesel
Allis-Chalmers Mfg. Co.
Buckeye Machine Co.
Busch-Sulzer
McEwen Bros.
McIntosh & Seymour Corp.
Midwest Engine Co.
Nordberg Mfg. Co.
Taylor Machine Co.
Worthington Pump & Mchy. Corp.

Engines, Gasoline
Sterling Engine Co.

Engines, Gas and Oil
Buckeye Machine Co.
Chicago Pneumatic Tool Co.
Cooper Co., C. & G.
De La Vergne Mach. Co.
Hooven-Owen-Rentschler Co.
Ingersoll-Rand Co.
Power Mfg. Co., The
Taylor Machine Co.
Westinghouse Elec. & Mfg. Co.

Engines, Pumping
Allis-Chalmers Mfg. Co.
Morris Machine Works
Nordberg Mfg. Co.
Worthington Pump & Mach. Corp.

Engines, Steam
Allis-Chalmers Mfg. Co.
Ball Engine Co.
Buckeye Engine Co.
Buffalo Forge Co.
Chicago Pneumatic Tool Co.
Cooper Co., C. & G.
Erie City Iron Works
Hooven-Owen-Rentschler Co.
Morris Machine Works
Nordberg Mfg. Co.
Ridgway Dynamo & Eng. Co.
Skinner Engine Co.
Vilter Mfg. Co.
Westinghouse Elec. & Mfg. Co.
Worthington Pump & Mchy. Corp.

Evaporators
Griscom-Russell Co.
Ross Heater & Mfg. Co.
Wheeler Cond. & Engr. Co.
Whitlock Coil Pipe Co.

Evaporator Feed Heaters
Griscom-Russell Co.

Evaporators, Multi-Stage
Wheeler Cond. & Engr. Co.

Exhaust Heads
Burt Mfg. Co.
Direct Separator Co.
Hoppes Mfg. Co.
Ohio Body & Blower Co.
Patterson & Kelley Co., Inc.
Sterling Blower Co.
Sturtevant Co., B. F.
Watson & McDaniel Co.
Whitlock Coil Pipe Co.
Wright-Austin Co.

Expansion Joints
American Dist. Steam Co.
Badger & Sons Co., E. B.
Griscom-Russell Co.
Hercules Float Works
Howard Iron Works
Ross Heater & Mfg. Co.
Warren Webster & Co.
Wheeler Mfg. Co., C. H.

Extension Valve Boxes
Kennedy Valve Mfg. Co.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Feed Water Filters
(See Filters, Feed Water)

Feed Water Heaters
Alberger Heater Co.
American Blower Co.
Elliott Co.
Griscom-Russell Co.
H. S. B. W. Cochrane Corp-(Formerly Harrison Safety Boiler Works)
King Construction Co.
Nat'l Pipe Bending Co.
Ohio Body & Blower Co.
Patterson Kelley Co.
Permutit Co.
Pratt & Cady Co.
Ross Heater & Mfg. Co.
Warren Webster & Co.
Wheeler Cond. & Engr. Co.
Worthington Pump & Mchy. Corp.

Feed Water Purifiers
Alberger Heater Co.
Blackburn Smith Corp.
H. S. B. W. Cochrane Corp-(Formerly Harrison Safety Boiler Works)
International Filter Co.
Pratt & Cady Co., Inc.
Webster & Co., Warren
Yarnall-Waring Co.

Feed Water Regulators
Am. Steam Gauge & Valve Mfg. Co.
Chaplin-Fulton Mfg. Co.
D'Este Co., Julian
Elliott Co.
Foster Engineering Co.
Mason Regulator Co.
Northern Equipment Co.
S.-C. Regulator Co.
Squires Co., C. E.
Wing Mfg. Co., L. J.
Wright Austin Co.

Feeders, Boiler Compound
Bird-Archer Co., The
Lunkenheimer Co.
Richardson-Phenix Co.

Fibre, Sheets, Rods, Tubes and Specialties
Wilmington Fibre Spec'ty Co.

Filtering & Circulating System for Lubricating Oil
Bowser & Co., S. F.
Nugent & Co., W. W.
Richardson Phenix Co.
Wayne Oil Tank & Pump Co.

Filters, Feed Water
Blackburn-Smith Corp.
Griscom-Russell Co.

Filters, Oil
Anderson Co., V. D.
Blackburn-Smith Corp.
Bowser & Co., S. F., Inc.
Burt Mfg. Co.
Elliott Co.
Nugent & Co., Inc., Wm. W.
Richardson-Phenix Co.

Filters, Oil, Removal
Permutit Co.

Filters, Water
International Filter Co.
N. Y. Continental Jewell Filtration Co.
Permutit Co.

Fire Brick, Cement and Mortar
Betson Plastic Fire Brick Co.
A. P. Green Fire Brick Co.
Johns Manville Co.
Jointless Fire Brick Co.
McLeod & Henry
Obermayer Co., The S.
Pitts & Kitts Mfg. & Supply Co.
Quigley Furnace Specialties Co.
Walsh Fire Clay Prod. Co.

Fire Extinguishers
Badger & Sons Co., E. B.
Johns-Manville

Firebox Blocks
A. P. Green Fire Brick Co.
McLeod & Henry Co.
Walsh Fire Clay Prod. Co.

Fittings, Ammonia
Carbondale Machine Co.
Greene, Tweed & Co.
York Mfg. Co.

Fittings, Oil Pipe Union Cinch
Richardson Phenix Co.

Fittings, Steel
Crane Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.

Fixtures, Electrical
Adapti Co., The

Flanges
American Dist. Steam Co.
Dart Mfg. Co., E. M.
Jefferson Union Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.

Flashlights
National Carbon Co.

Flat Wire—Strip Steel
Am. Steel & Wire Co.

Floats
Anderson Co., V. D.
Hercules Float Works
Reliance Gauge Column Co.

Flow Meters
(See Meters, Flow)

Floor Gratings
Irving Iron Works

Flooring, Mastic and Cork Tile
Johns-Manville

Flue Cleaners
Chesterton Co., A. W.
Huyette & Co., Inc., Paul B.
Nat'l Flue Cleaner Co.

Forges
Buffalo Forge Co.

Forgings, Monel Metal
The International Nickel Co.

Fuel Oil
The Sun Co.

Fuel Oil Systems
Bowser & Co., S. F.

Furnace Blocks
Drake Non Clinkering Furnace Block Co.
McLeod & Henry
Walsh Fire Clay Prod. Co.

Furnace Door Arch
Betson Plastic Fire Brick Co.
Jointless Fire Brick Co.
McLeod & Henry Co.
Obermayer Co., The S.
Walsh Fire Clay Prod. Co.

Furnace Lining
Betson Plastic Fire Brick Co.
A. P. Green Fire Brick Co.
Jointless Fire Brick Co.
McLeod & Henry
Obermayer Co., The S.
Quigley Furnace Specialties Co.
Walsh Fire Clay Prod. Co.

Furnaces
Automatic Furnace Co.
Cokal Stoker Corporation
Detroit Stoker Company
Green Engineering Co.
Hofft Co., M. A.
Illinois Stoker Co.
McClave Brooks Co.
Murphy Iron Works
Rust Engr. Co.
Sterling Blower Co.

Fuses
Chicago Fuse Co.
Economy Fuse & Mfg. Co.
General Electric Co.
Johns-Manville
Westinghouse Elec. & Mfg. Co.

Gage Boards
Ashton Valve Co.
Foxboro Co.
Schaffer & Budenberg Mfg. Co., The

Gage Cocks
(See Cocks, Gage)

Gage Glasses
Advance Packing & Supply Co.
Chesterton Co., A. W.
Durabla Mfg. Co.
Garlock Packing Co.
Quaker City Rubber Co.

Gage Glass Guards and Shields
Durabla Mfg. Co.
Paul B. Huyette Co., Inc.

Gage Glass Reflectors
Durabla Mfg. Co.

Gage Testing Outfit
Am. Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Schaeffer & Budenberg Mfg. Co.

Gages, Caliper
Williams & Co., J. H.

Gages, Differential
Brown Instrument Co.

Gages, Draft
Bristol Co.
Brown Instrument Co.
Defender Automatic Reg. Co.
Dwight Mfg. Co.
Ellison, Lewis M.
Hays Corp., Jos. W.
Huyette & Co., Inc., Paul B.
Nat'l Flue Cleaner Co.
Pierce Co., Wm. B.

Gages, Hydraulic
Brown Instrument Co.

Gages, Oil
Richardson-Phenix Co.

Gages, Pressure
Am. Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Bristol Co.
Brown Instrument Co.
Crosby Steam Gage & Valve Co.
Schaeffer & Budenberg Mfg. Co., The

Gages, Recording
Am. Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Bristol Co.
Brown Instrument Co.
Defender Automatic Ry. Co.
Foxboro Co.
Jos. W. Hays Corporation
Schaeffer & Budenberg Mfg. Co., The

Gages, Vacuum
Ashton Valve Co.
Bristol Co.
Greene, Tweed & Co.

Gages, Water
American Dist. Steam Co.
Brown Instrument Co.
Crosby Steam Gage & Valve Co.
Greene, Tweed & Co.
Huyette Co., Inc., Paul B.
Jenkins Bros.
Lunkenheimer Co.
Nat'l Flue Cleaner Co.
Ohio Brass Co.
Penberthy Injector Co.
Reliance Gauge Column Co.

Gas Burners
Davidson Gas Burner & Welding Co., N. C.
Tate-Jones & Co. Inc.

Gas Exhausters
General Electric Co.
Ingersoll-Rand Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.

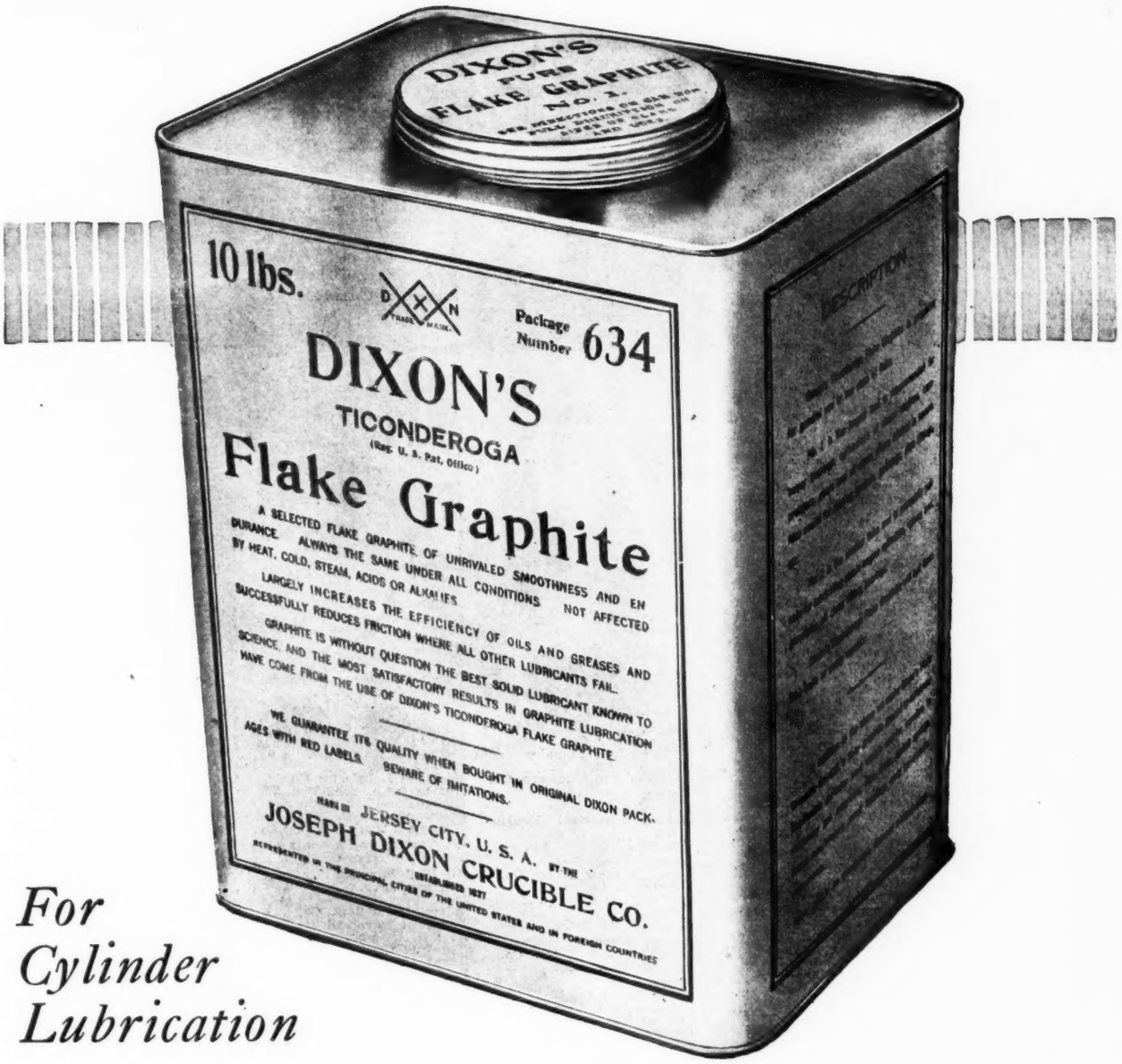
Gas Producers
Milwaukee Reliance Boiler Works
Westinghouse Elec. & Mfg. Co.
Worthington Pump & Mach. Corp.

Gaskets
Advance Pkg. & Supply Co.
Akron Metallic Gasket Co.
Crane Co.
Diamond Rubber Co.
Durabla Mfg. Co.
Eureka Packing Co.
Flexitalic Gasket Co.
Garlock Packing Co.
Gen'l Asbestos & Rubber Co.
Goetze Gasket & Pkg. Co.
Goodrich Rubber Co., B. F.
Greene, Tweed & Co.
Jenkins Bros.
Johns-Manville
McCord Mfg. Co.
N. Y. Belting & Packing Co.
Quaker City Rubber Co.
Sarco Co.
Smooth-On Mfg. Co.
United States Rubber Co.
Wilcox Mfg. Co., E. A.

Gaskets, Asbestos
Dominion Asbestos & Rubber Co.
Gen'l Asbestos & Rubber Co.

Gaskets, Copper Rubber
Akron Metallic Gasket Co.
E. A. Wilcox Mfg. Co.

Gaskets, Fibre
Wilmington Fibre Specialty Co.


DIXON'S
FLAKE GRAPHITE
No. 1.
10 lbs.
Package Number 634
DIXON'S
TICONDEROGA
(Reg. U. S. Pat. Office)
Flake Graphite
A SELECTED FLAKE GRAPHITE OF UNRIVALED SMOOTHNESS AND ENDURANCE. ALWAYS THE SAME UNDER ALL CONDITIONS. NOT AFFECTED BY HEAT, COLD, STEAM, ACIDS OR ALKALIES
LARGELY INCREASES THE EFFICIENCY OF OILS AND GREASES AND SUCCESSFULLY REDUCES FRICTION WHERE ALL OTHER LUBRICANTS FAIL.
GRAPHITE IS WITHOUT QUESTION THE BEST SOLID LUBRICANT KNOWN TO SCIENCE, AND THE MOST SATISFACTORY RESULTS IN GRAPHITE LUBRICATION HAVE COME FROM THE USE OF DIXON'S TICONDEROGA FLAKE GRAPHITE.
WE GUARANTEE ITS QUALITY WHEN BOUGHT IN ORIGINAL DIXON PACKAGES WITH RED LABELS. BEWARE OF IMITATIONS.
MADE IN JERSEY CITY, U. S. A. BY THE
JOSEPH DIXON CRUCIBLE CO.
ESTABLISHED 1827
REPRESENTED IN THE PRINCIPAL CITIES OF THE UNITED STATES AND IN FOREIGN COUNTRIES
DESCRIPTION

For Cylinder Lubrication

Dixon's Ticonderoga Flake Graphite is the only kind that can be safely used in engine cylinders. Special lubricators feed it automatically in dry form to the cylinder walls. Soon the metal becomes so smooth that only a small amount of oil is required. The cost of lubrication can be easily reduced at least 50 percent.

Wet steam will not wash it from cylinder walls. Superheated steam can not vaporize it. It stays put and furnishes a velvety surface that aids oil to do its work effectively.

Unless you are satisfied that no further economies can be made in your plant, we invite you to write for Booklet No. 94-C "Graphite for Cylinder Lubrication."

Made in JERSEY CITY, N. J., by the
Joseph Dixon Crucible Company
Established 1827

Gaskets, Water Gage
Morse, R. F.

Gasoline Electric Generating Sets
Sturtevant Co., B. F.

Gasoline Storage System
Wayne Oil Tank & Pump Co.

Gates, Bin
Brown Hoisting Machy. Co.
Conveyors Corp. of America
R. H. Beaumont Co.
Green Engr. Co.
Jeffrey Mfg. Co.
Chain Belt Co.
Link-Belt Co.

Gates, Sluice
Chapman Valve Mfg. Co.

Gears
Chain Belt Co.
De Laval Steam Turbine Co.
Earle Gear & Machine Co.
General Electric Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Moore Steam Turbine Corp.

Generating Sets
General Electric Co.
Allis-Chalmers Mfg. Co.
Ridgway Dynamo & Eng. Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.

Generator Coolers
Badger & Sons Co., E. B.
Ridgway Dynamo & Eng. Co.
Spray Engine Co.

Generators, Electric
Allis-Chalmers Mfg. Co.
General Electric Co.
Kerr Turbine Co.
Moore Steam Turbine Corp.
Ridgway Dynamo & Eng. Co.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.

Governors, Pressure
Mason Regulator Co.
Northern Equipment Co.
S.-C. Regulator Co.

Governors, Pump
Chaplin-Fulton Mfg. Co.
Davis Regulator Co., G. M.
Fisher Governor Co., Inc., The
Foster Engineering Co.
Illinois Engineering Co.
Marion Mch., Fdry. & Supply Co.
Mason Regulator Co.
Northern Equipment Co.
S.-C. Regulator Co.
Squires Co. C. E.
Strong, Carlisle & Hammond Co., The
Watson & McDaniel Co.
Warren Webster & Co.
Wright, Austin Co.

Governors, Steam Engine
Gardner Governor Co.

Graphite
Dixon Crucible Co., Jos.
Garlock Packing Co.
Greene, Tweed & Co.
Obermayer Co., S.

Grate Bars
Cokal Stoker Corporation
McEwen Bros.
Valley Iron Works

Grates
Armstrong Mfg. Co.
Automatic Furnace Co., The
Babcock & Wilcox Co., The
Combustion Eng. Corp.
Cyclone Grate Bar Co.
Flynn & Emrich
Green Engineering Co.
Hofft M. A., Co.
Hulson Grate Co.
International Engineering Works
Kelly Fdry. & Mch. Co.
Marion Mch., Fdry. & Supply Co.
McClave-Brooks Co.
McEwen Bros.
Neemes Bros.
Power Turbo Blower Co.
Springfield Boiler Co.
Valley Iron Works
Washburn & Granger, Inc.

Grating, Flooring and Subway
Irving Iron Works
Washburn & Granger, Inc.

Grease
Adam Cooks Sons Co.
Dearborn Chemical Co.
Dixon Crucible Co., Jos.
Keystone Lubricating Co.
N. Y.-N. J. Lubricant Co.
Ohio Grease Co.
The Sun Co.
Texas Company

Grease Cups (Compressed Air)

Grease Extractors
Am. Steam Gage & Valve Mfg. Co.
Blackburn-Smith Corp.
Elliott Co.
Griscom-Russell Co.
Lagonda Mfg. Co.

Grease Guns
Bowser & Co., S. F.

Grinders, Air & Elec. Portable
Chicago Pneumatic Tool Co.

Hammers, Pneumatic
Chicago Pneumatic Tool Co.

Hand Pumps for Oil & Gasoline
Bowser & Co., S. F.

Hangers, Shafting
Chain Belt Co.
Chas. P. Bond Co.
Cresson-Morris Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Valley Iron Works

Heaters, Domestic
Alberger Heater Co.
Patterson Kelley Co.
Ross Heater & Mfg. Co.

Heaters, Feed Water
(See Feed Water Heaters)

Heating and Ventilating Systems
Buffalo Forge Co.
Illinois Engineering Co.
Whitlock Coil Pipe Co.
Warren Webster & Co.

High Pressure Blowers
(See Blowers, Forced Draft)

Hoist Hooks
Williams & Co., J. H.

Hoists
Gillis & Geoghegan
Godfrey Conveyor

Hoists, Air
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.

Hoists, Electric
Beaumont Co., R. H.
Brown Hoisting Mach. Co
Gillis & Geoghegan
Link-Belt Co.
Nordberg Mfg. Co.
Shepard Elec. Crane & Hoist Co.

Hoists, Steam
Nordberg Mfg. Co.
Sullivan Machinery Co.

Hoppers, Coal and Ash
Beaumont Co., R. H.
Brown Hoisting Mchy. Co.
Green Engineering Co.
Jeffrey Mfg. Co.
Link-Belt Co.

Hose, Air
Chicago Pneumatic Tool Co.

Hose, Clamps
Chicago Pneumatic Tool Co.

Hose, Rubber
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
N. Y. Belting & Pkg. Co.
Pioneer Rubber Mills
Quaker City Rubber Co.
United States Rubber Co.

Hydrants
Kennedy Valve Mfg. Co.

Hydrometers and Hygrometers
Brown Instrument Co.

Ice Machine Repairs
Underwood & Co., H. B.

Ice Making Machinery
Norwalk Iron Wks.
York Mfg. Co.

Ice and Refrigerating Machinery. (See Refrigerating Machinery)

Incinerators
Washburn & Granger, Inc.

Indicators, Ammonia
American Steam Gauge & Valve Mfg. Co.
Trill Indicator Co.

Indicators, Draft
Brown Instrument Co.

Indicators, Flow
Richardson-Phenix Co.

Indicators, Speed
Biddle, James C.
Brown Instrument Co.
Starrett Co., L. S.

Indicators, Steam Engine
American Steam Gauge & Valve Mfg. Co.
Crosby Steam Gage & Valve Co.
Robertson & Sons, Jas. L.
Trill Indicator Co.

Injectors
American Injector Co.
Eynon-Evans Corp.
Jenkins Bros.
Lunkenheimer Co.
Penberthy Injector Co.
Powell Co., Wm.
Schutte & Koerting Co.
Sherwood Mfg. Co.

Instruments, Electrical Measuring
Weston Elec. Inst. Co.

Kerosene Pumps & Tanks
Bowser & Co., S. F.

Ladder Treads, Non-Slipping
Irving Iron Works

Lamps, Arc
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Lamps, Incandescent
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Lathe Dogs, Safety
Williams & Co., J. H.

Lathes, Foot Power
Barnes Co., W. F. & John

Leathers, Hydraulic and Cup
Schieren Co., Chas. A.

Leather Lace
Schieren Co., Chas. A.

Lubricants
Sun Co., The

Lubricators, Cylinder
Greene, Tweed & Co.
Keystone Lubricating Co.
Lunkenheimer Co.
McCord Mfg. Co.
McCullough Mfg. Co.
Manzel Bros.
Michigan Lubricator Co.
Ohio Grease Co.
Powell Co., Wm.
Richardson-Phenix Co.

Lubricators, Force Feed
Greene, Tweed & Co.
Lunkenheimer Co.
McCord Mfg. Co.
McCullough Mfg. Co.
Manzel Bros.
Powell Co., Wm.
Richardson-Phenix Co.

Lubricators, Graphite
Farnsworth Company
Richardson-Phenix Co.

Lubricating Oil Filtering, Tanks and Pumps
Bowser & Co., S. F.
Richardson-Phenix Co.

Machine Tools
The Fairbanks Co.

Machine Works, Special
Griscom-Russell Co.
Lammert & Mann
Link-Belt Co.

Machinists' Tools
Williams & Co., J. H.

Mats and Matting
Goodyear Tire & Rubber Co.
N. Y. Belting & Packing Co.

Metal, Bearing
Allan & Son, A.
Magnolia Metal Co.

Meters, Air
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Coal
C. J. Mfg. Co.

Meters, Electrical Measuring
Weston Elec. Inst. Co.

Meters, Feed Water
Republic Flow Meter Co.
Webster & Co., Warren
Worthington Pump & Machy. Corp.
Yarnall-Waring Co.

Meters, Flow
Republic Flow Meters Co.
Yarnall-Waring Co.

Meters, Gas
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.
Sloan Co., Inc., A. H.

Meters, Heat
Brown Instrument Co.

Meters for Oil, Kerosene & Gasoline
Bowser & Co., S. F.
Sloan Co., Inc., A. H.
Wayne Oil Tank & Pump Co.

Meters, Oil
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.
Richardson-Phenix Co.
Sloan Co., Inc. A. H.
Worthington Pump & Mch. Corp.

Meters, Steam
American Dist. Steam Co.
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Water
American Dist. Steam Co.
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
H. S. B. W. Cochrane Corp. (Formerly Harrison Safety Boiler Works)
Hoppes Mfg. Co.
Republic Flow Meters Co.
Worthington Pump & Mch. Corp.
Yarnell-Waring Co.

Micrometers
Starrett Co., L. S.

Milli-Ammeters
Brown Instrument Co.

Milli-Voltmeters
Brown Instrument Co.

Mill, Mining & Railway Supplies
The Fairbanks Co.

Motors, Electric
Allis-Chalmers Mfg. Co.
Crocker-Wheeler Co.
General Electric Co.
Ridgway Dynamo & Engine Co.
Westinghouse Elec. & Mfg. Co.

Motors, Water
Roto Co.

Multiwhirl Oil Cooler
Griscom-Russell Co.

Oil and Grease Cups
Adam Cooks Sons Co.
American Injector Co.
Keystone Lubricating Co.
Lunkenheimer Co.
Ohio Grease Co.
Penberthy Injector Co.
Powell Co., Wm.
Richardson-Phenix Co.

Oil Burners
Davidson Gas Burner & Welding Co., N. C.
Hammel Oil Burning Equipment Co., Inc.
Schutte & Koerting
Tate-Jones & Co., Inc.

Oil Coolers
Alberger Heater Co.
Griscom-Russell Co.
Schutte & Koerting Co.

Oil Pumps, Sets
The Hammel Oil Burner Co.

Oil Purifiers
Richardson-Phenix Co.

Oil Reservoirs
Bowser & Co., S. F.
Burt Mfg. Co.
Coatesville Boiler Wks.
Elliott Co.
Lancaster Iron Works
McEwen Bros.
Richardson-Phenix Co.

Oil Separators
(See Separators, Oil)

Oil Strainers
Griscom-Russell Co.

Oiling Devices and Systems
Bowser & Co., S. F.
Burt Mfg. Co.
Elliott Co.
Lunkenheimer Co.
McCord Mfg. Co.
McCullough Mfg. Co.
Manzel Bros.
Michigan Lubricator Co.
Nugent & Co., Inc., Wm. W.
Richardson-Phenix Co.
Sherwood Mfg. Co.
Wayne Oil Tank & Pump Co.

Oil Testing Instruments
Tagliabue Mfg. Co.

Oil Well Supplies
McEwen Bros.

Oils
Adam Cooks Sons Co.
Dearborn Chemical Co.
N. Y.-N. J. Lubricant Co.
The Sun Co.
Texas Company

Packing, Asbestos
Advance Pkg. & Supply Co.
Chesterton Co., A. W.
Dominion Asbestos & Rubber Co.
Durabla Mfg. Co.
General Asbestos & Rubber Co.
Johns-Manville
Johns-Pratt Co.
N. Y. Belting & Packing Co.
Sarco Co.

Packing, Cylinder
General Asbestos & Rubber
N. Y. Belting & Pkg. Co.
Rooksby & Co., E. J.

Packing, Flax
Chesterton Co., A. W.
General Asbestos & Rubber Co.
Johns-Manville

Packing, Hydraulic
Advance Packing & Supply Co.
Chesterton Co., A. W.
Eureka Packing Co.
Garlock Packing Co.
General Asbestos & Rubber Co.
Goetze Gasket & Pkg. Co.
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
Johns-Manville
N. Y. Belting & Packing Co.
Quaker City Rubber Co.
Schieren Co., Charles A.
United States Rubber Co.
Walker & Co., Ltd., Jas.

Packing, Leather
Schieren Co., Charles A.

Packing, Metallic
American Steam Packing Co.
Eureka Packing Co.
Garlock Packing Co.
Merrill & Co., Wm. B.
N. Y. Belting & Packing Co.
Steel Mill Packing Co.
Walker & Co. Ltd., Jas

Packing, Piston
Chesterton Co., A. W.
General Asbestos & Rubber Co.
Goodrich Rubber Co., B. F.
Johns-Manville
N. Y. Belting & Packing Co.
United States Rubber Co.

Packing, Pump Valve
Garlock Packing Co.
Goodrich Rubber Co., B. F.
Johns-Manville
N. Y. Belting & Packing Co.
Quaker City Rubber Co.
United States Rubber Co.

Packing, Rod
American Steam Packing Co.
Chesteron Co., A. W.
Dominion Asbestos & Rubber Co.
Durabla Mfg. Co.
Eureka Packing Co.
Garlock Packing Co.
General Asbestos & Rubber Co.
Goetze Gasket & Pkg. Co.
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.
Johns-Manville
Merrill & Co., Wm. B.
N. Y. Belting & Packing Co.
Pioneer Rubber Mills
Quaker City Rubber Co.
Steel Mill Packing Co.
United States Rubber Co.
Westinghouse Elec. & Mfg. Co.

Packing Sheet
Advance Pkg. & Supply Co.
Dominion Asbestos & Rubber Co.
Durabla Mfg. Co.
Eureka Packing Co.
Garlock Packing Co.
General Asbestos & Rubber Co.
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.
Jenkins Bros.
Johns-Manville
Johns-Pratt Co.
McCord Mfg. Co.
N. Y. Belting & Packing Co.
Pioneer Rubber Works
Quaker City Rubber Co.
U. S. Rubber Co.
Walker & Co., Ltd., Jas.

Packing, Valve Stem
Eureka Packing Co.
Garlock Packing Co.
General Asbestos & Rubber Co.
Greene, Tweed & Co.
Johns-Manville
McCord Mfg. Co.
N. Y. Belting & Packing Co.
Quaker City Rubber Co.
Steel Mill Pkg. Co.
United States Rubber Co.

Paint, Cold Water
Johns-Manville

Paint, Graphite
Dixon Crucible Co., Jos.

Paint, Metal
Durabla Mfg. Co.

Paint, Smoke Stack
Dixon Crucible Co., Jos.

Pipe
Byers Co., A. M.
M. J. Dougherty Co.
Kellogg Co., M. W.
National Tube Co.
Power Piping Co.
Whitlock Coil Pipe Co.

Pipe Bending
Am. Pipe Bending Mach. Co.
M. J. Dougherty Co.
Kellogg Co., M. W.
National Pipe Bending Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.
Whitlock Coil Pipe Co.

Pipe Bends
American Tube & Pipe Bending Co.

Pipe, Bent and Coiled
Whitlock Coil Pipe Co.

Pipe Coils
Abendroth & Root Mfg. Co.
Locomotive Superheater Co.
National Pipe Bending Co.
Nat'l Valve & Mfg. Co.
Whitlock Coil Pipe Co.

Pipe Cutting and Threading Machines
Armstrong Mfg. Co.
Curtis & Curtis Co.
Toledo Pipe Threading Mach. Co.
Trimont Mfg. Co.

Pipe Fittings
American Dist. Steam Co.
M. J. Dougherty Co.
Jefferson Union Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip Co.
Walworth Mfg. Co.

Pipe Headers, Welded
M. J. Dougherty Co.

Pipe Joint Compound
Dixon Crucible Co., Jos.

What Does My Coal Handling Cost?

In these days of ever increasing costs, have you stopped to ask yourself the above question recently? We do not know how you are handling your coal and bulky materials at present, nor what it costs you. But we do know and want to tell you how well a Brownhoist Locomotive Crane will do the work. Also at what a low cost per ton it will do it. Then you will have a basis for comparison.

The Brownhoist Crane and Bucket will handle from 500 to 700 tons per 10-hour day, depending on the size of the crane and the distance the coal is handled. And it will do this with less breakage and less spilling than would be possible by hand shoveling. The total cost of a Brownhoist, including all operating costs, the interest on your investment and depreciation is about $15 per day. Does your present equipment equal this performance? Besides, the Brownhoist will switch the cars, do all your heavy handling and is built to give you 24 hours' daily service if you need it. Shall we tell you where some of these cranes are being used on work similar to your own?

BROWNHOIST

Locomotive Cranes and Buckets

are used in all parts of the world. They make an excellent combination for handling bulk materials, such as coal, coke, stone, etc. Each is strongly built, as the users will tell you. And they will give continuous service, day and night, if necessary.

Write for Catalog K.

The Brown Hoisting Machinery Company

40 Years in Crane Business **Cleveland, Ohio, U. S. A.**

Engineers and Manufacturers of Heavy Dock Machinery, Bridge Cranes, etc., as well as smaller Cranes and Hoists

Branch Offices in New York, Pittsburgh Chicago and San Francisco

Pipe, Steel Riveted
Biggs Boiler Works Co.
Pipe, Welded and Seamless
National Tube Co.

Pipe, Wood
American Dist. Steam Co.

Pipe, Wrought Iron
Byers Co., A. M.

Pipe Wrought Steel
National Tube Co.

Piping Contractors
Dougherty Co., M. J.
Pittsburgh Piping & Equip. Co.
National Valve & Mfg. Co.

Piping Fabricators
Dougherty Co., M. J.
National Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.

Piping, High Pressure
A. M. Beyers Co.
Crane Co.
M. J. Dougherty Co.
National Tube Co.
Nat'l Valve Mfg. Co.
Pittsburgh Piping & Equip. Co.

Planimeters
American Steam Gauge & Valve Mfg. Co.
Robertson & Sons Jas. L.
Trill Indicator Co.

Plumbago
Dixon Crucible Co., Jos.
Plumbers' Tools
Williams & Co., J. H.

Pneumatic Tools
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Poles, Tubular Steel
National Tube Co.
Power Transmission Machinery
Cresson-Morris Co.
Primers, Pump
Eynon-Evans Corp.
Schutte & Koerting Co.

Pulleys
American Pulley Co.
Bond Co., Chas. P.
Caldwell, W. E. Co., Inc.
Greene, Tweed & Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Saginaw Mfg. Co.
Valley Iron Works

Pulverized Fuel, Equipment
Combustion Engineering Corp.
The Bonnot Company
Fuller Lehigh Co.
Jeffrey Mfg. Co.
Quigley Furnace Specialties Co.
Williams Patent Crusher & Pulverizer Co.

Pumps, Acid
Trimont Rotary Power Co.
Lea-Courtenay Co., The
Davidson Co., M. T.
Worthington Pump & Mach. Corp.

Pumps, Air
Croll-Reynolds
Davidson Co., M. T.
Norwalk Iron Wks.
Schutte & Koerting Co.
Wheeler Condenser & Engr. Co.
Wheeler Mfg. Co., C. H.
Worthington Pump & Mach. Corp.

Pumps, Boiler Feed
Cameron Co., A. S.
Coppus Engr. & Equip. Co.
Dayton Dowd Co.
Dean Bros. Steam Pump Wks.
Deming Co.
Earle Gear & Machine Co.
Farnsworth Company
Gardner Governor Co.
Lea-Courtenay Co., The
Manistee Iron Works
Morris Machine Wks.
Pratt & Cady Co., Inc.
Traylor Engr. & Mfg. Co.
Warren Steam Pump Co.
Western Pump Co.

Pumps, Brine
Cameron Co., A. S.
Lea-Courtenay Co., The
Pratt & Cady Co., Inc.
Western Pump Co.

Pumps, Centrifugal
Alberger Pump & Condenser Co.
Allis-Chalmers Mfg. Co.
American Well Works
Buffalo Steam Pump Co.
Cameron Steam Pump Wks., A. S.
Coppus Engr. & Equip. Co.
Dayton-Dowd Co.
De Laval Steam Turbine Co.
Earle Gear & Machine Co.
Frederick Iron & Steel Co.
Goulds Mfg. Co.
Lea-Courtenay Co.
Manistee Iron Works Co.
Midwest Engine Co.
Morris Machine Works
Pennsylvania Pump & Compressor Co.
Pratt & Cady Co., Inc.
Taber Pump Co.
Terry Steam Turbine Co.
Western Pump Co.
Westinghouse Elec. & Mfg. Co.
Wheeler Condenser & Engr. Co.
Wheeler Mfg. Co., C. H.
Worthington Pump & Mach. Corp.

Pump, Compression, Gas
Norwalk Iron Wks.

Pumps, Condenser
A. S. Cameron Co.
Davidson Co., M. T.
Farnsworth Company
Lea-Courtenay Co.
Pratt & Cady Co., Inc.

Pumps, Deep Well
American Well Works
Cameron Co., A. S.
Davidson Co., M. T.
Deming Co.
Morris Machine Works
Weber Subterranean Pump Co.
Worthington Pump & Mach. Corp.

Pumps, Fire
Gardner Governor Co.
Lea-Courtenay Co.
Western Pump Co.

Pumps, Force Feed (See Lubricators)

Pumps, Elevator
Cameron Co., A. S.
Davidson Co., M. T.
Western Pump Co.

Pumps, Grease
Richardson-Phenix Co.

Pumps, Irrigation and Drainage
Lea-Courtenay Co.
Western Pump Co.
Worthington Pump & Machy. Corp.

Pumps, Jet
Worthington Pump & Mach. Corp.

Pumps, Mine
Cameron Co., A. S.
Deming Co.
Lea-Courtenay Co.
Manistee Iron Works Co.
Pratt & Cady Co., Inc.
Western Pump Co.
Worthington Pump & Machy. Corp.

Pumps, Natural Gas
Norwalk Iron Wks.

Pump Liners, Monel Metal
The International Nickel Co.

Pumps, Oil
Bowser & Co., S. F.
Cameron Co., A. S.
Gardner Governor Co.
McCullough Mfg. Co.
Manzel Bros.
Nugent & Co., W. W.
Pratt & Cady Co., Inc.
Richardson-Phenix Co.
Sherwood Mfg. Co.
Wayne Oil Tank & Pump Co.
Western Pump Co.
Worthington Pump & Mach. Corp.

Pumps, Power
Gardner Governor Co.
Deming Co.
Warren Steam Pump Co.

Pumps, Rotary
Taber Pump Co.
Lea-Courtenay Co.

Pumps, Self Measuring
Wayne Oil Tank & Pump Co.

Pumps, Steam
Buffalo Steam Pump Co.
Davidson Co., M. T.
Dean Bros., Steam Pump Wks.
Gardner Governor Co.
McGowan Co., The John H.
Morris Machine Works
Pennsylvania Pump & Compressor Co.
Pratt & Cady Co., Inc.
Terry Steam Turbine Co.
Warren Steam Pump Co.
Wheeler Condenser & Engr. Co.
Worthington Pump & Mach. Corp.

Pumps, Turbine
Allis-Chalmers Co.
Buffalo Steam Pump Co.
Cameron Co., A. S.
Kerr Turbine Co.
Manistee Iron Works
Morris Machine Wks.

Pumps, Vacuum
American Well Works
Buffalo Steam Pump Co.
Cameron Co., A. S.
Chicago Pneumatic Tool Co.
Croll-Reynolds
Davidson Co., M. T.
Dean Bros. Steam Pump Wks.
Gardner Governor Co.
Goulds Mfg. Co.
Ingersoll-Rand Co.
Manistee Iron Works Co.
Pratt & Cady Co., Inc.
Schutte & Koerting Co.
Trimont Rotary Power Co.
Warren Steam Pump Co.
Westinghouse Elec. & Mfg. Co.
Wheeler Mfg. Co.
Wheeler Condenser & Engr. Co.
Worthington Pump & Mach. Corp.

Pumps, Water-Works
Allis-Chalmers Mfg. Co.
American Well Works
Cameron Co., A. S.
Earle Gear & Machine Co.
Lea-Courtenay Co., The
Manistee Iron Works Co.
Midwest Engine Co.
Morris Machine Wks.
Pratt & Cady Co., Inc.
Terry Steam Turbine Co.
Western Pump Co.
Worthington Pump & Mach. Corp.

Pyrometers
Bristol Co.
Brown Instrument Co.
Defender Automatic Regulator Co.
The Jos. W. Hays Corp.
Thwing Instrument Co.

Pyrometers, Electric Automatic
Brown Instrument Co.

Pyrometers, Electric Temperature
Brown Instrument Co.

Pyrometers, Controlling, for Electric, Gas or Oil Furnaces
Brown Instrument Co.

Pyrometers, Electric Indicating
Brown Instrument Co.

Pyrometers, Electric Temperature Signalling
Brown Instrument Co.

Pyrometers, Electric Recording
Brown Instrument Co.

Pyrometers, Recording
Brown Instrument Co.
Hays Corp., Jos. W.
Thwing Instrument Co.

Rawhide Rope
Chas. A. Schieren Co.

Refrigerating Machinery
Carbondale Machine Co.
De La Vergne Machine Co.
Johns-Manville
Norwalk Iron Wks.
Vilter Mfg. Co.
Vogt Mach. Co., Inc.
York Mfg. Co.

Regulators, Current
American Galco, Inc.

Regulators, Damper, Draft and Fan
American Dist. Steam Co.
American Galco, Inc.
Coppus Engr. & Equip. Co.
Davis Regulator Co., G. M.
Defender Automatic Regulator Co.
Hagan Corp.
Mason Regulator Co.
Power Turbo Blower Co.
Robertson & Sons, James L.
Ruggles-Klingemann Mfg. Co.
Warren Webster & Co.
Wing Mfg. Co., L. J.

Regulators, Feed Water (See Feed Water Regulators)

Regulators, Gas
American Galco, Inc.
Hagan Corp.
Mason Regulator Co

Regulators, Moisture
American Galco, Inc.

Regulators, Pressure
American Galco, Inc.
Brown Instrument Co.
Chaplin-Fulton Mfg. Co.
Crane Co.
Davis Regulator Co., G. M.
D'Este Co., Julian
Elliott Co.
Engineer Co., The
Fisher Governor Co.
Hagan Corp.
Illinois Engineering Co.
Mason Regulator Co.
Ohio Brass Co.
Squires & Co., C. E.
Strong, Carlisle & Hammond Co.
Tagliabue Mfg. Co.
Watson & McDaniel Co.

Regulators, Pulp
American Galco, Inc.
Hagan Corp.
Mason Regulator Co.

Regulators, Pump
Chaplin-Fulton Mfg. Co.
Davis Regulator Co., G. M.
D'Este Co., Julian
Foster Engineering Co.
Mason Regulator Co.
Northern Equipment Co.
S. C. Regulator Co.
Squires & Co., C. E.
Strong, Carlisle & Hammond Co.

Regulators, Stoker
American Galco, Inc.
Hagan Corp.
Mason Regulator Co.

Regulators, Temperature
Bristol Co.
Brown Instrument Co.
Foxboro Co.
Hagan Corp.
Sarco Company, Inc.
Tagliabue Mfg. Co.

Regulators, Voltage
American Galco, Inc.

Regulators, Vacuum
American Galco, Inc.
Mason Regulator Co.

Revolution Counters
Ashton Valve Co.
Brown Instrument Co.
Starrett Co., L. S.

Rheostats
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Rock Drills
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Rod Ends
Williams & Co., J. H.

Rods, Monel Metal
The International Nickel Co.

Roofing, Corrugated Ready, Built Up
Johns-Manville

Rope
American Mfg. Co.

Rope Dressing
Cling Surface Co.

Rope Transmission
American Mfg. Co.
American Steel & Wire Co.

Rubber Goods
Dominion Asbestos & Rubber Co.
Goodyear Tire & Rubber Co.
New York Belting & Packing Co.
Pioneer Rubber Co.
Quaker City Rubber Co.
U. S. Rubber Co.

Safety Step
Irving Iron Wks.

Scale Removers
Chesterton Co., A. W.
General Specialty Co.
Lagonda Mfg. Co.
Liberty Mfg. Co.
Pierce Co., Wm. B.
Robertson & Son, Jos. L.
The Roto Co.

Scales, Automatic Coal
Brady Foundry Co., James A.
Reliance Weighing Machine Co.

Scales—All Kinds
The Fairbanks Co.

Screens, Shaking and Revolving
Gifford-Wood Co.
Jeffrey Mfg. Co.
Link-Belt Co.

Screens, Water Intake
Chain Belt Co.
Link-Belt Co.

Screws, Monel Metal
The International Nickel Co.

Seamless Steel Tubing
National Tube Co.

Second-Hand Equipment (See Searchlight Section)

Separators, Ammonia
Carbondale Machine Co.
Elliott Co.
Strong, Carlisle & Hammond Co.
York Mfg. Co.

Separators, Oil
American District Steam Co.
Anderson Co., V. D.
Crane Co.
Director Separator Co.
Elliott Co.
Griscom-Russell Co.
H. S. B. W. Cochrane Corp. (Formerly Harrison Safety Boiler Works)
Hoppes Mfg. Co.
Illinois Engineering Co.
Nashua Machine Co.
National Pipe Bending Co.
Ohio Body & Blower Co.
Robertson & Sons, Jas. L.
Schutte & Koerting Co.
Strong, Carlisle & Hammond Co., The
Warren Webster & Co.
Wright-Austin Co.

Separators, Steam
American District Steam Co.
Crane Co.
Direct Separator Co.
Elliott Co.
Griscom-Russell Co.
H. S. B. W. Cochrane Corp. (Formerly Harrison Safety Boiler Works)
Hoppes Mfg. Co.
Illinois Engineering Co.
Nashua Machine Co.
W. H. Nicholson & Co.
Ohio Body & Blower Co.
Patterson & Kelley Co., Inc.
James L. Robertson & Sons
Schutte & Koerting Co.
Strong, Carlisle & Hammond Co., The
Warren Webster & Co.
Whitlock Coil Pipe Co.
Wright-Austin Co.

Sewage Ejectors
Blackburn Smith Corp.

Shafting
Cresson-Morris Co.
National Tube Co.
Valley Iron Works

Shafting, Tubular Material
National Tube Co.

Sightfeeds
Richardson-Phenix Co.

Skylights
Burt Mfg. Co.

Sockets—Wire Rope
Williams & Co., J. H.
Soot Cleaners (See Blowers Soot)

Soot Scrapers
Wm. B. Pierce Co.

Spray Nozzles (See Cooling Plants and Ponds)

Springs
American Steel & Wire Co.

Stacks
Heine Safety Boiler Works
E. Keeler Co.
Lancaster Iron Works
Morrin Climax Boiler Co.

Stack, Tank and Grate Work
Union Iron Works

Stack Lining, Vitribestos
Johns-Manville

Stair Tread, Non-Slipping
Irving Iron Works

Stationary Vacuum Cleaning Plants
Sturtevant Co., B. F.

Steam Eliminators
W. H. Nicholson & Co.

Steam Traps (See Traps)
Steam Turbines (See Turbines)

Steam Turbine Electric Generating Sets
Sturtevant Co., B. F.
Steel Plate Work
Heine Safety Boiler Works
Lancaster Iron Works

Stokers Anthracite
Combustion Engr. Corp.
Stokers, Chain Grate
Automatic Furnace Co.
Babcock & Wilcox Co., The
Green Engineering Co.
Illinois Stoker Co.
Laclede-Christy Co.
Westinghouse Elec. & Mfg. Co.

Stokers, Forced Draft Chain Grate
Illinois Stoker Co.
Stokers, Hand Operated
Carrigan Engineering Co.
Cokal Stoker Corporation
Files Engr. Co.
Flynn & Emrich
Hofft Co., M. A., The
McClave-Brooks Co.
Valley Iron Works
Stokers, Mechanical
Detroit Stoker Co.
Frederick Engineering Co.

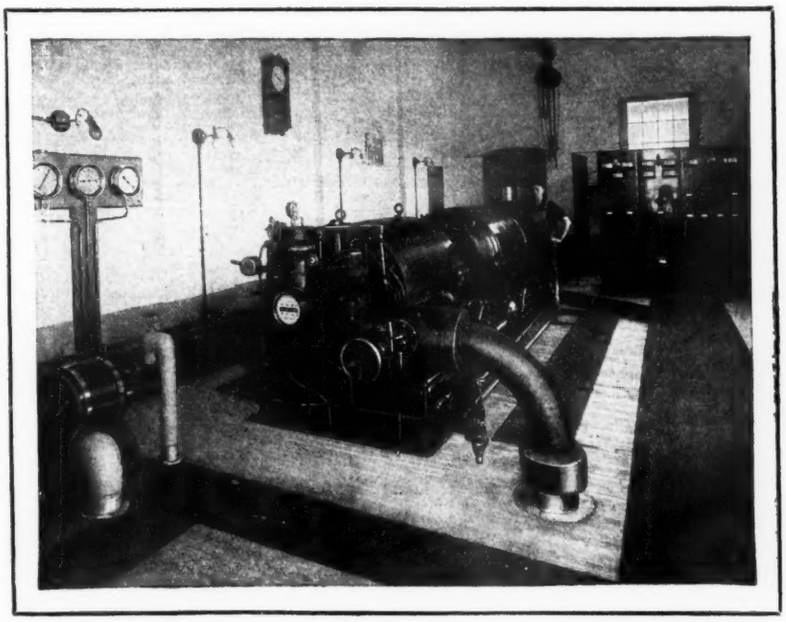
Stokers, Underfeed
American Engineering Co.
Cokal Stoker Corporation
Combustion Engr. Corp.
Frederick Engineering Co.
M. A. Hofft Co.
Laclede-Christy Co.
Murphy Iron Works
Riley Stoker Co. Stanford
J. H. Roach & Co.
Under-Feed Stoker Co. of America
United Conveyors Corp.
Westinghouse Elec. & Mfg. Co.

Strainers, Oil
Elliott Co.
Mason Regulator Co.
Richardson-Phenix Co.
Strainers, Pump Suction
Elliott Co.
Newman Mfg. Co.
Warren Webster & Co.
Strainers, Water
American Injector Co.
Badger & Sons Co., E. B.
Elliott Co.
Manning Maxwell & Moore, Inc.
Mason Regulator Co.

Superheaters
Babcock & Wilcox Co., The
Heine Safety Boiler Co.
Locomotive Superheater Co
Power Specialty Co.
Whitlock Coil Pipe Co.
Switchboards
General Electric Co.
Westinghouse Elec. & Mfg. Co.
Switches, Electric
General Electric Co.
Westinghouse Elec. & Mfg. Co.
Swivels, Hook
Williams & Co., J. H.

KERR TURBINE CO.

Wellsville, N. Y.



Economy

Turbo Generators

Tachometers
Biddle, James G.
Brown Instrument Co.
Schaeffer & Budenberg Mfg. Co., The
Zernickow, O.

Tanks
Biggs Boiler Works Co.
Bowser Co., S. F.
W. E. Caldwell Co., Inc.
Green Engr. Co.
Heine Safety Boiler Works
Lancaster Iron Works
McEwen Bros.
Morrin Climax Boiler Co.
Union Iron Works
Wayne Oil Tank & Pump Co.
Whitlock Coil Pipe Co.
Wright-Austin Co.

Tanks, Seamless Steel
Nat'l Tube Co.

Tape
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Thermit
Metal & Thermit Corp.

Thermometers
Bristol Co., The
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.
The Jos. W. Hays Corp.
Schaeffer & Budenberg Mfg. Co.

Thermometers, Flue Gas
Brown Instrument Co.
Dwight Mfg. Co.

Thermometers, Recording
Bristol Co., The
Brown Instrument Co.
Foxboro Co.
Schaeffer & Budenberg Mfg. Co., The
Tagliabue Mfg. Co.

Thermometers, Resisting
Brown Instrument Co.

Thermostats
Bristol Co., The
Brown Instrument Co.

Tools, Electric
Chicago Pneumatic Tool Co

Tools, Small
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(See Power Transmission Machinery)

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Davis Regulator Co., G. M.
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Traps, Hydromatic
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Traps, Non-Return
Davis Regulator Co., G. M.
Illinois Engineering Co.
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Traps, Radiator
Johns-Manville
Sarco Company, Inc.
Warren Webster & Co.

Traps, Return
Albany Steam Trap Co.
Farnsworth Co.
Morehead Mfg. Co.
Nashua Machine Co.
Schutte & Koerting Co.
Strong, Carlisle & Hammond Co., The
Templeton Mfg. Co.

Traps, Steam
Albany Steam Trap Co.
American Steam Gauge & Valve Mfg. Co.
Anderson Co., V. D.
Crane Co.
Davis Regulator Co., G. M.
D'Este Co., Julian
Direct Separator Co.
Elliott Co.
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Farnsworth Co.
Fisher Governor Co.
Golden-Anderson Valve Specialty Co.
Illinois Engineering Co.
Jenkins Bros.
Johns-Manville
Morehead Mfg. Co.
Nashua Machine Co.
Nicholson & Co., W. H.
Ohio Body & Blower Co.
Reliance Gauge Column Co.
Sarco Company, Inc.
Schutte & Koerting Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.
Watson & McDaniel Co.
Warren Webster & Co.
Wright-Austin Co.

Traps, Vacuum
American Steam Gauge & Valve Mfg. Co.
Davis Regulator Co., G. M.
Farnsworth Co.
Illinois Engineering Co.
Morehead Mfg. Co.
Nashua Machine Co.
Sarco Company, Inc.
Schutte & Koerting Co.
Strong, Carlisle & Hammond Co., The
Templeton Mfg. Co.
Warren Webster & Co.

Traps, Variable Pressure
Davis Regulator Co., G. M.
Farnsworth Company

Trolleys, I-Beam
Brown Hoisting Machinery Co.

Link-Belt Co.

Trucks & Wheelbarrows
The Fairbanks Co.

Tubes, Boiler
Nat'l Tube Co.

Tube Cleaners
(See Scale Removers)
(See Soot Blowers)

Tube Cutters
Lagonda Mfg. Co.
Liberty Mfg. Co.

Tube Expanders
Ingersoll-Rand Co.
Liberty Mfg. Co.

Tubing
American Tube & Pipe Bending Co.
National Tube Co.
Wheeler Condenser & Engr. Co.

Tubing, Monel Metal
The International Nickel Co.

Turbines, Steam
Allis-Chalmers Mfg. Co.
American Well Works
Coppus Eng. & Equip. Co.
De Laval Steam Turbine Co.
General Electric Co.
Green Fuel Economizer Co.
Hooven, Owens, Rentschler Co.
Kerr Turbine Co.
Midwest Engine Co
Moore Steam Turbine Corp.
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B. F. Sturtevant Co.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.
Wing Mfg. Co., L. J.

Turbines, Water
Allis-Chalmers Mfg. Co.

Unions and Union Fittings
Crane Co.
Dart Mfg. Co., E. H.
Jefferson Union Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Valves, Angle
Pratt & Cady Co., Inc.
Richardson Phenix Co.

Valve Disc
Allan & Son, A.
Diamond Rubber Co.
Dominion Asbestos & Rubber Co.
Durabla Mfg. Co.
Goetze Gasket & Pkg. Co.
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
N. Y. Belting & Packing Co.
Ohio Brass Co.
Pratt & Cady Co., Inc.

Valve Reseating Machines
Leavitt Machine Co., The

Valve Washers, Leather
Schieren Co., Charles A.

Valves, Ammonia
Carbondale Machine Co.
Chapman Valve Mfg. Co.
Kennedy Valve & Mfg. Co.
Merrill Co., The
Pratt & Cady Co., Inc.
York Mfg. Co.

Valves, Automatic Cutoff
Davis Regulator Co., G. M.
Golden-Anderson Valve Spec. Co.
Kelly Controller Co.
Lagonda Mfg. Co.
Nelson Valve Co.
Schutte & Koerting Co.
Strong, Carlisle & Hammond Co.

Valves, Back Pressure
American Dist. Steam Co.
Chapman Valve Mfg. Co.
Davis Regulator Co., G. M.
The Fisher Governor Co.
Foster Engineering Co.
H. S. B. W. Cochrane Corp. (Formerly Harrison Safety Boiler Works)
Jenkins Bros.
Schutte & Koerting Co.

Valves, Balanced
Davis Regulator Co., G. M.
Mason Regulator Co.

Valves, Blowoff
Cadman Mfg. Co., A. W.
Chapman Valve Mfg. Co.
Crane Co.
Elliott Co.
Hancock Inspirator Co.
Homestead Valve Mfg. Co.
Jenkins Bros.
Lunkenheimer Co.
Merrill Co., The
Nelson Valve Co.
Powell Co., Wm.
Richardson-Phenix Co.
Yarnall-Waring Co.

Valves, Brass and Iron Body
Homestead Valve Mfg. Co.
Merrill Co., The
National Valve & Mfg. Co.
Nelson Valve Co.
Pittsburgh Piping & Equipment Co.
Pratt & Cady Co., Inc.
Walworth Mfg. Co.

Valves, Bypass
Chapman Valve Mfg. Co.
Davis Regulator Co., G. M.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Mason Regulator Co.
Nelson Valve Co.

Valves, Check
Bayer Steam Soot Blower Co.
Chapman Valve Mfg. Co.
Crane Co.
Davis Regulator Co.
Golden-Anderson Valve Spec. Co.
Greene, Tweed & Co.
Hancock Inspirator Co.
Jenkins Bros.
Nelson Valve Co.
Ohio Brass Co.
Richardson-Phenix Co.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Schutte & Koerting Co.
Strong, Carlisle & Hammond Co.

Valves, Coal Bin
Green Engr. Co.
Link-Belt Co.
Jeffery Mfg. Co.

Valves, Electrically Operated
Davis Regulator Co., G. M.
Golden-Anderson Valve Spec. Co.
Mason Regulator Co.
Nelson Valve Co.
Pratt & Cady Co., Inc.

Valves, Exhaust Relief
Chapman Valve Mfg. Co.
Crane Co.
Davis Regulator Co., G. M.
Fisher Governor Co., Inc.,
Foster Engineering Co.
H. S. B. W. Cochrane Corp. (Formerly Harrison Safety Boiler Works)
Jenkins Bros.
Schutte & Koerting Co.

Valves, Float
American Steam Gauge & Valve Mfg. Co.
Davis Regulator Co., G. M.
Elliott Co.
Fisher Governor Co.
Foster Engineering Co.
Golden-Anderson Valve Spec. Co.
Homestead Valve Mfg. Co.
Mason Regulator Co.

Valves, Gate
Chapman Valve Mfg. Co.
Crane Co.
Greene, Tweed & Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Nelson Valve Co.
New Bedford Valve Mfg. Co.
Ohio Brass Co.
Penberthy Injector Co.
Pittsburgh Piping & Equip. Co.
Powell Co., Wm.
Schutte & Koerting Co.

Valves, Globe and Angle
Bayer Steam Soot Blower Co.
Crane Co.
Eynon-Evans Corp.
Golden-Anderson Valve Spec. Co.
Hancock Inspirator Co.
Homestead Valve Mfg. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Nelson Valve Co.
New Bedford Valve Mfg. Co.
Ohio Brass Co.
Powell Co.
Richardson-Phenix Co.
Schutte & Koerting Co.

Valves, Hose Gate
Kennedy Valve Mfg. Co.

Valves, Hydraulic
Chapman Valve Mfg. Co.
Crane Co.
Homestead Valve Mfg. Co.
Kennedy Valve Mfg. Co.
Merrill Co., The
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equipment Co.
Schutte & Koerting Co.
Yarnall-Waring Co.

Valves, Indicator Post
Kennedy Valve Mfg. Co.
Pratt & Cady Co., Inc.

Valves, Intake
Chapman Valve Mfg. Co.
Pratt & Cady Co., Inc.

Valves, Non-Return Stop
Chapman Valve Mfg. Co.
Davis Regulator Co., G. M.
Foster Engineering Co.
Golden-Anderson Valve Spec. Co.
Jenkins Bros.
Kelly Controller Co.
Lagonda Mfg. Co.
Lunkenheimer Co.
Nelson Valve Co.
Shutte & Koerting Co.
Strong, Carlisle & Hammond Co., The

Valves, Pop Safety
American Steam Gauge & Valve Mfg. Co.
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Valves, Pump
Chapman Valve Mfg. Co.
Garlock Packing Co.
Goodyear Tire & Rubber Co.
Hill Pump Valve Co.
Jenkins Bros.
N. Y. Belting & Packing Co.
Pratt & Cady Co., Inc.
Quaker City Rubber Co.
Richardson-Phenix Co., The
United States Rubber Co.

Valves, Radiator
Illinois Engineering Co.
Kennedy Valve Mfg. Co.
Ohio Brass Co.
Warren Webster & Co.

Valves, Radiator Regulating
American Dist. Steam Co.
Warren Webster & Co.

Valves, Reducing
American Dist. Steam Co.
American Ga co. Inc.
Chaplin-Fulton Mfg. Co.
Davis Regulator Co., G. M.
Elliott Co.
Fisher Governor Co., The
Foster Engineering Co.
Golden-Anderson Valve Spec. Co.
Illinois Engineering Co.
Mason Regulator Co.
Ohio Brass Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.
Watson & McDaniel Co.

Valves, Regrinding
Lunkenheimer Co.
Nelson Valve Co.
Penberthby Injector Co.
Powell Co., Wm.
Richardson-Phenix Co.

Valves Regulating
Davis Regulator Co., G. M.
Defender Automatic Regulators Co.
Foster Engineering Co.
Golden-Anderson Valve Spec. Co.
Illinois Engineering Co.
Mason Regulating Co.
Ohio Brass Co.
Squires Co., C. E.

Valves, Relief
American Dist. Steam Co.
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Crane Co.
Davis Regulator Co., G. M.
Golden-Anderson Valve Spec. Co.
Lunkenheimer Co.
Nelson Valve Co.
Schutte & Koerting Co.

Valves, Safety
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Crosby Steam Gage & Valve Co.
Foster Engineering Co.
Golden-Anderson Valve Spec. Co.
Jenkins Bros.
Lunkenheimer Co.

Valves, Stop
Chapman Valve Mfg. Co.
Crane Co.
Golden-Anderson Valve Spec. Co.
Jenkins Bros.
Lunkenheimer Co.
Merrill Co.
Nelson Valve Co.
Schutte & Koerting Co.

Valves, Superheated Steam
Chapman Valve Mfg. Co.
Davis Regulating Co., G. M.
Golden-Anderson Valve Spec. Co.
Hancock Inspirator Co.
Homestead Valve Mfg. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Merrill Co.
Nelson Valve Co.
Pratt & Cady Co., Inc.
Richardson-Phenix Co.
Schutte & Koerting Co.

Valves, Thottle
Golden-Anderson Valve Specialty Co.
Hancock Inspirator Co.
Homestead Valve Mfg. Co.
Lunkenheimer Co.
Merrill Co.
Nelson Valve Co.
Richardson-Phenix Co.
Schutte & Koerting Co.

Valve Trim, Monel Metal
The International Nickel Co.

Valves, Trip Throttle
Davis Regulator Co., G. M.
Mason Regulator Co.

Valves, Vacuum
Illinois Engineering Co.
Mason Regulator Co.
Merrill Co.
Sarco Co., Inc.
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Ventilators
Burt Mfg. Co.
Clarage Fan Company
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Vises
Curtis & Curtis Co.
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Anderson Co., V. D.
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The Paul B. Huyette Co.
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Water Cooling Towers (See Cooling Towers)

Water Purifying Apparatus
Permutit Co.

Water Supply System
Weber Subterranean Pump Co.

Waterproofing
Johns-Manville
Bird-Archer Co., The

Water Softening Apparatus
H. S. B. W. Cochrane Corp. (Formerly Harrison Safety Boiler Works)
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Walworth Mfg. Co.

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Trimont Mfg. Co.

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Curtis & Curtis Co.
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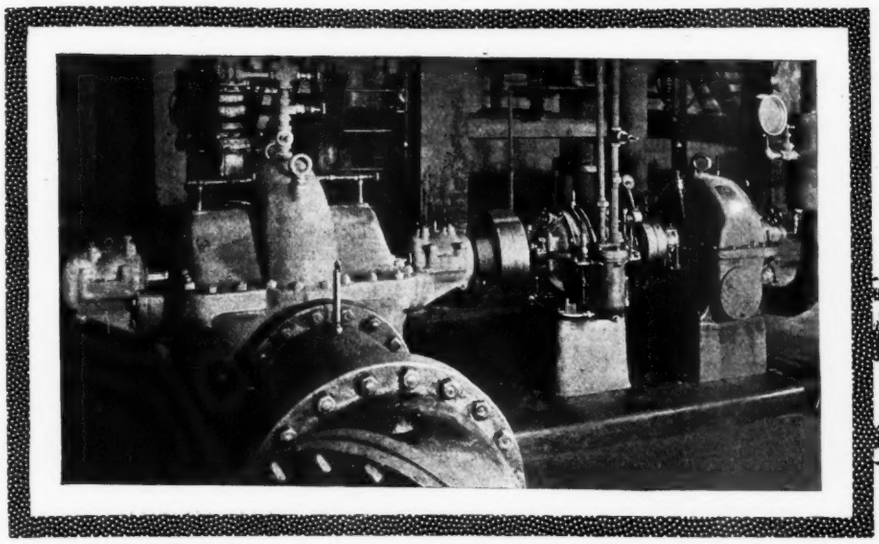
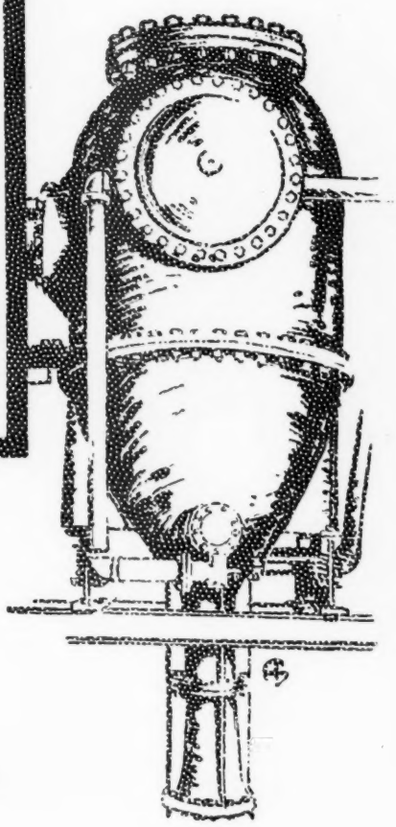
Williams & Co., J. H.
Walworth Mfg. Co.

Wrenches, Socket
Williams & Co., J. H.





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ALPHABETICAL INDEX TO ADVERTISERS—Continued from page 160

	Page
Schutte & Koerting Co.	119
Searchlight Section (see Classified Index, Page 158)	66-80
Shepard Electric Crane & Hoist Co.	144
Smith Gas Engineering Co.	124
Smith & Serrell	146
Smooth-On Mfg. Co.	47
Springfield Boiler Co.	128
Squires Co., C. E.	115
Star Brass Works	142
Starrett Co., L. S.	80
Steel Mill Packing Co.	90
Strong, Carlisle & Hammond Co.	141
Sturtevant Co., B. F.	136-137-146
Sundh Electric Co.	144
Sullivan Machinery Co.	139
Sun Co.	64
Taber Pump Co.	116
Tagliabue Mfg. Co., C. J.	64
Tate Jones Mfg. Co.	104
Taylor Sons Co., The Chas.	130
Templeton Mfg. Co.	134
Terry Steam Turbine Co.	157
Texas Co.	159
Thompson Mfg. Co.	116
Thwing Inst. Co.	144
Toch Brothers	147
Toldeo Pipe Threading Machine Co.	86
Tracy Engineering Co.	122
Traylor Engineering & Mfg. Co.	158
Trimont Mfg. Co.	46
Troy Engine Co.	138
Uehling Instrument Co.	122
Underfeed Stoker Co. of America	110
Underwood Corp., H. B.	138
United Conveyor Corp.	104
Union Iron Works	129
Vilter Mfg. Co.	142
Vogt Machine Co., Henry	142
Voorhees Rubber Mfg. Co.	92
Walker & Co., Ltd., James	92
Walworth Mfg. Co.	86
Washburn & Granger Co.	102
Watson & McDaniel Co.	134
Webster Mfg. Co.	102
Weston Electrical Instrument Co.	144
Westinghouse Elec. & Mfg. Co.	6
Wheeler Condenser & Engrg. Co.	142
Wheeler Mfg. Co., C. H.	116
Whitlock Coil Pipe Co.	114
Wickes Boiler Co., The	128
Williams Co., J. H.	84
Wilmington Fibre Specialty Co.	90
Wing Mfg. Co., L. J.	105
Worthington Pump & Mach. Corp.	82
Yarnall-Waring Co.	21
York Mfg. Co.	142
Zernickow, O.	124

INDEX TO SEARCHLIGHT SECTION

	Page
American Air Compressor Works	77
Brearley, H. P.	74
Brown-Hunkele Corporation	70
Carrell & Co., W. A.	75
Central Machinery & Equipment Inspection Bureau	77
Consolidated Mchy. & Wrecking Co.	74
Curtiss Willis Co.	77
Crockwell Mine & Mill Supply Co.	80
Davis, J. F.	68
Duchamp, Arthur	77
Duquesne Electric & Manufacturing Co.	71-72-74
Essex Engine Corp.	77
General Equipment Co.	73-77
Gov. Ads.	77-79
Harris Bros.	72
Harris Pump & Supply Co.	69
Hobson, R. B.	74
International Time Recording Co.	75
Klein & Co., Nathan	72
McCarthy, J. J.	67
McMillan & Co.	72
MacGovern & Co.	77
Machinery Utilities Co.	75
Manufacturers' Equip. Exchange	72
Markman Engrg. Co.	74
Morris, Samuel C.	73
National Pipe & Supply Co.	77
Perry Buxton Doane Co.	80
Phoenix Utility Co.	77
Positions Vacant	67
Positions Wanted	67
Power Equipment Co.	77
Power Machinery Exchange	71
Randle Machinery Co.	70
Ross Power Equipment Co.	73-77
Stewart & Co., Paul	68
Technical Products Co.	73
Toomey, Frank	75
Universal Machinery Co.	74
Wickes Machinery Co.	73

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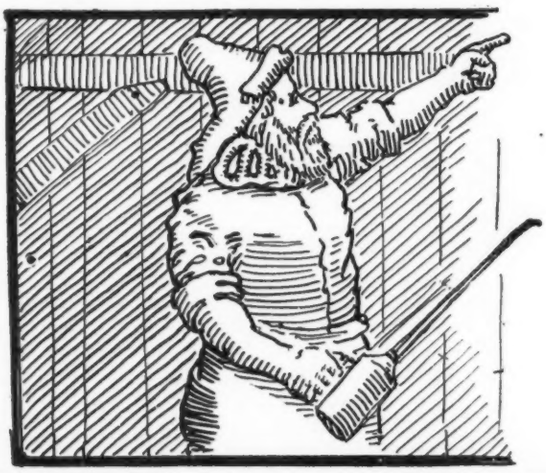

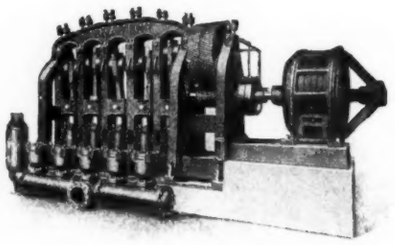

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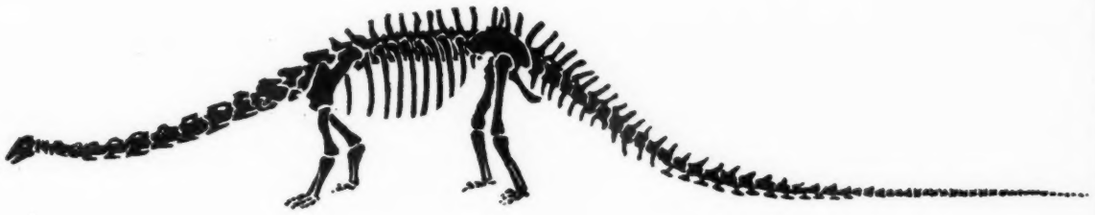

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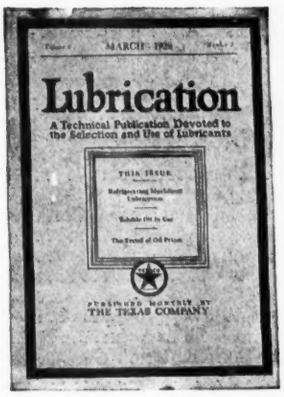

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ALPHABETICAL INDEX TO ADVERTISEMENTS

Searchlight listings headed under separate index on 2nd preceding page

Page

Abendroth & Root Mfg. Co. 128
Ad Editor's Page 2
Adam Cook's Sons Co..... 65
Advance Packing and Supply Co. .. 90
Albany Steam Trap Co. 134
Alberger Pump and Condenser Co.122
Allis-Chalmers Mfg. Co. 135
American Crucible Products Co. .. 83
American Galco, Inc. 124
American Injector Co. 118
American Manufacturing Co. 84
American Pipe Bending Machine Co. 86
American Steam Gauge and Valve Mfg. Co. 122
American Steel & Wire Co. 130
American Tube & Pipe Bending Co. 86
Armstrong Mfg. Co. 86
Armstrong Mfg. Co. 110
Ashton Valve Co. 100
Automatic Fuel Saving Corp. ...42-43
Automatic Furnace Co. 108

Babbitt Steam Specialties Co. 146
Babcock & Wilcox Co. 129
Badger & Sons Co., E. B. 88
Bailey Meter Co. 27
Ball Engine Co. 140
Barber-Greene Company 33
Barnes Co., W. F. & John..... 64
Betson Plastic Fire Brick Co. 132
Biddle, J. G. 146
Blackburn-Smith Corp. 122
Boiler Tube Co. of America 88
Bonnot Co., The 103
Bowser & Co., Inc., S. F. 96
Brady Fdry. Co., Jas. A. 108
Bristol Co. .....Back Cover
Brosius, Edgar E..... 64
Brown Hoisting Machinery Co. ...153
Buffalo Steam Pump Co. 115
Builders Iron Foundry 125
Burhorn, Edwin Co. 142
Burt Mfg. Co. 48
Busch-Sulzer Bros. Diesel Engine Co. 138

C. J. Mfg. Co. 120
Cadman Mfg. Co., A. W. 101
Caldwell Co., W. E. 146
Carbondale Machine Co. 143
Chadburn Engineering Co. 118
Chain Belt Co. 34-35
Chaplin-Fulton Mfg. Co. 120
Chapman Valve Co. 44
Chesterton Co., A. W. 127
Chicago Fuse Mfg. Co. 146
Chicago Pneumatic Co. 25
Cling-Surface Co. 94
Coatesville Boiler Works 130
Cokal Stoker Corp. 110
Conveyor Corp. of America 41
Combustion Engineer'g Corp. 14-15-104
Connelly Boiler Co., D. 128
Cooling Tower Co. 142
Coppus Engineering and Equipment Co. 106
Crandall Packing Co. 142
Crane Co. 98
Cresson-Morris Co. 146
Crocker-Wheeler Co. 144
Crosby Steam Gage & Valve Co. ..123
Curtis & Curtis Co. 12
Cyclone Grate Bar Co. 108

Dart Mfg. Co., E. M. 88
Davidson Co., M. T. 115
Davis Regulator Co., G. M. 99
Davison Gas Burner & Welding Co. N. C. 106
Dayton-Dowd Co. 116

Page

Dean Bros. Steam Pump Works ..116
Dearborn Chemical Co. 5
Detrick Co., M. H. 130
Detroit Stoker Co. 111
Dexter Co., I. H. 146
Direct Separator Co. 122
Directory of Engineers 66
Dixon Crucible Co., Joseph 151
Dougherty, M. J. Co. 87
Durabla Mfg. Co. 31

Earle Gear & Mach. Co., The 116
Economy Fuse & Mfg. Co. 145
Edge-Moor Iron Co. 128
Elliott Co. 7
Ellis Co., W. E. 108
Engineer Co., The 132
Erie City Iron Works 129
Excello Mfg. Co. 132
Eynon-Evans Corp. 104

Fitzgibbon Boiler Co. 128
Files Engineering Co. 110
Flynn & Emrich Co. 108
Foxboro Co. 124
Frederick Engineering Co. 109
Fuller-Lehigh Co. 102

Gardner Governor Co. 117
General Specialties Co. 126
Garlock Packing Co. 38
Gifford-Wood Co. 102
Girtanner Engineering Corp. 102
Goetze Gasket and Packing Co. ... 92
Golden-Anderson Valve Specialties Co. 40
Graton & Knight Mfg. Co. 93
Green Engineering Co. 32
Green Fire Brick Co., A. P. 132
Green Fuel Economizer Co. 106
Greene, Tweed & Co. .....Back Cover
Griscom-Russell Co. 45
Guarantee Construction Co. 134

Hammell Oil Burning Equip. Co. ..104
Hagan Co., Geo. T. 106
Hayward Co. 102
Heine Safety Boiler Co.....Bet. 32-33
Hill Pump Valve Co. 13
Hofft Co., M. A. 108
Hoppes Mfg. Co., The 114
Homestead Valve Mfg. Co. 30
Howard Iron Works 84
H. S. B. W.—Cochrane Corporation. 63
Hunt Co., C. W. 146

Ideal Commutator Dresser Co. 144
Illinois Stoker Co. 107
Ingersoll-Rand Co. 29
International Engrg. Works 128
International Nickel Co. 100

Jefferson Union Co. 88
Jeffrey Mfg. Co., The 28
Jenkins Bros. 4
Jenkins Machine Co. 140
Johnson Machine Co., Carlyle 146
Johnson Oil Refining Co. 97
Jointless Firebrick Co. 131
Johns-Manville Co. 18-19

Kellogg Co., M. W. 88
Kerr Turbine Co. 155
Keystone Lubricating Co. 3
King Refractories Co. 132

Laclede Christy Clay Prod. Co. 112-113
Ladew Co., E. R. 91
Lagonda Mfg. Co. .....3rd Cover
Lea Courtenay Co. 115
Liberty Mfg. Co. 9

Page

Liptak Fire-Brick Arch Company..133
Locomotive Superheater Co..... 64
Lunkenheimer Co. 16-17

McClave Brooks Co. 26
McGowan Co., John H. 116
McGraw-Hill Book Co. 118-147
McEwen Bros. 138
McIntosh & Seymore Corp. 138
Manistee Iron Works 116
Manning, Maxwell & Moore Co. ..36-37
Marion Machine Foundry & Supply Co. 106
Mason Regulator Co. 81
Mechanicville Specialty Supply Mfg. Co. 104
Merrill Co., The 100
Merrill Co., Wm. B. 92
Michigan Lubricator Co. 122
Mono Corp. of America 124
Moore & White Co. 130
Moore Steam Turbine Corp. 138
Morehead Mfg. Co. 114
Morrin-Climax Boiler Co. 128
Morris Machine Works 115
Murphy Iron Works 20

Nashua Machine Co. 134
National Flue Cleaner Co. 126
National Pipe Bending Co. 114
National Valve & Mfg. Co. 89
Neemes Bros. 110
Nelson Valve Co. 8
Neptunus Supply Co. 126
New Bedford Valve Mfg. Co. 100
Nicholson & Co., W. H. 126
Northern Equipment Co. 22
Nugent & Co., Wm. W. 90

Obermayer Co., The S. 23
Ohio Brass Co. 100
Ohio Grease Co. 80
Orton & Steinbrenner Co. 102

Page Boiler Co. 129
Pardel Corp. 129
Patterson-Kelly Co., Inc., The 114
Pennsylvania Pump & Comp. Co...116
Permutit Co., The 120
Perolin Co. of America 24
Pierce Co., Wm. B. .....2nd Cover
Pioneer Rubber Mills 140
Pitts & Kitts Mfg. & Supply Co. ..130
Pittsburgh Piping & Equip. Co. .. 85
Portable Machinery Co. 102
Power Specialty Co. 90
Power Subscription 95
Power Turbo Blower Co. 106
Pratt & Cady Co., Inc. 100

Quaker City Rubber Co. 149
Quigley Furnace Co. 104-130

Republic Flow Meters Co. 39
Reliance Gauge Column Co. 121
Rhoads & Sons, J. E. 92
Richardson-Phoenix Co. 10-11
Riley Stoker Co., Ltd., Sanford....108
Roach & Co., Joseph H. 108
Robertson & Sons, Jos. L. 120
Rooksby & Co., E. J. 86
Ross Heater Mfg. Co. 142
Roto Co., The 126
Ruggles-Klingemann Mfg. Co. 120
Ruggles & Ruggles 126
Rust Engineering Co., The 130

Sarco Company, Inc., The 134
Schaeffer & Budenberg Mfg. Co. ...124
Schieren Co., Chas. A. 90

(Continued on page 158)